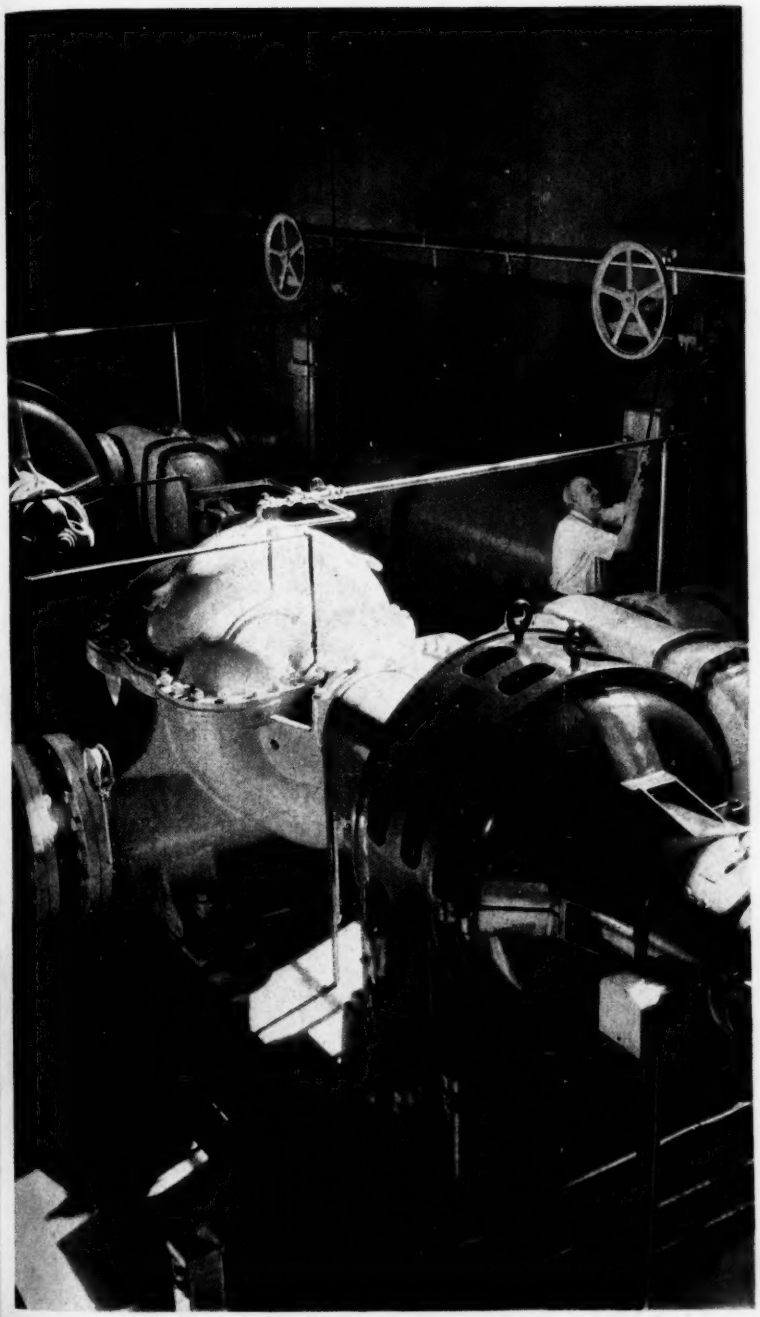
BUFFALO PUBLIC LIBRARY

Power Plant ENGINEERING



CONTENTS

Engineers' Preview 7
Helpful Bulletins 53
New Equipment News 56
What Leaders Say 67
Starting Up Steam Generators 68
The Gas Turbine Power Plant—II 74
Atomics 80
Eee Equals Em See Squared

THE PRACTICAL ENGINEER AND ELECTRICIAN

Commercial Tying of Knots 88
The Making of a Stationary Engineer 90
Practical Hints and Kinks 93
Drilling Shaft
Gear Puller
Portable Work Bench
Electric Fan Repair
How Electrical Machines Function—II 94
The "Other Fellow" Has the Accidents 97
Letters and Comments 98
Wanted, Job in Super Power Station
Still Running After 43 Years
Engineers Gold Mine
Questions and Answers 100
Excess Exhaust Steam
Would Enclosure Improve Oil Cooler?
Chimney Doesn't Produce Enough Draft
Automatic Stop Valves Chatter
Bus Bar Weights Chart 104

• • • • •

Thomas Alva Edison Born 100 Years Ago..105
Additional Topping at Sherman Creek 108
Annual Meeting of the ASME 113
TVA Raw and Treated Water 124

• • • • •

News from the Field.....126; Coming Events .....128; Obituaries.....142; Manufacturers' News.....144; Manufacturers' Personals..... 150; New Engineering Books.....152; Catalog Library.....156; Construction News.....172.

• • • • •

COVER: 125-HP ELLIOTT SYNCHRONOUS MOTOR DRIVING DAYTON-DOWD 18,000,000-GPD LOW-LIFT PUMP AT HAMMOND, INDIANA, WATER FILTRATION PLANT.

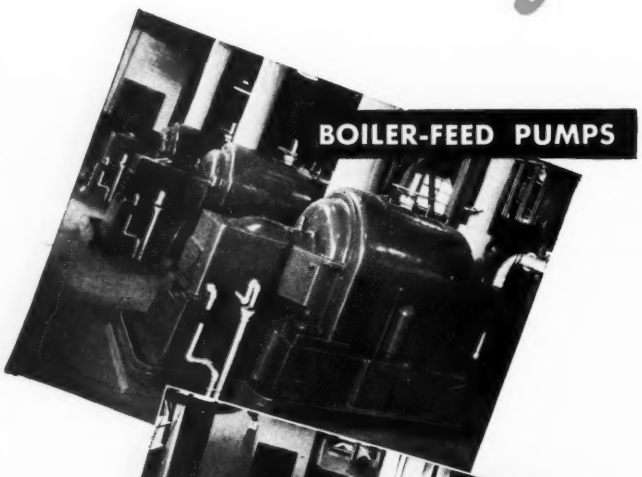
• • • • •

THE POWER ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY

FEBRUARY, 1947

Many motors bea

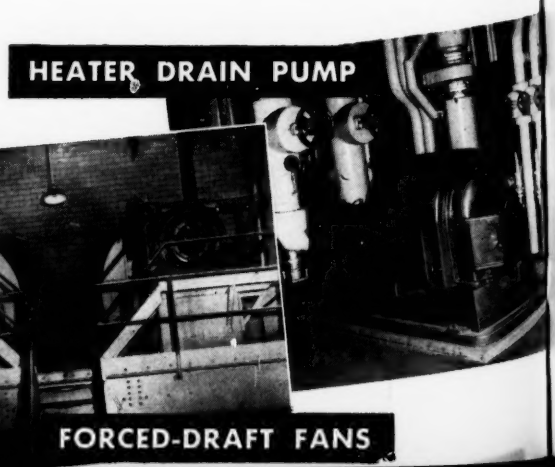
...in the new



This fine new plant will rank as one of the seven base-load steam-electric plants on the Central System power pool of the American Gas and Electric Company. Its equipment is naturally the result of careful and skilled selection. Practically all of the vital auxiliary services in this exceptional plant are powered by Elliott motors. This is a most striking endorsement of the service-giving qualities behind the familiar Elliott monogram on motor bearing caps so commonly seen in important power stations.

The numerous Elliott motors in this plant range in size up to 1000-hp. The 780,000 lb-per-hr deaerating feedwater heater is also Elliott-built, while several Elliott twin strainers protect valuable water-handling units against damage by water-borne foreign material. More information on this station appears in the Elliott Company publication "Powerfax", Winter issue.

Elliott



XUM

Power Plant ENGINEERING

February, 1947

VOLUME 51—NUMBER 2

Engineers' Preview 7

Helpful Bulletins 53

New Equipment News 56

What Leaders Say 67

Starting Up Steam Generators 68
By John C. Gore

The Gas Turbine Power Plant—II 74
By John I. Yellott

Atomics 80

Eee Equals Em See Squared
By Andrew W. Kramer

The Practical Engineer and Electrician 87

Thomas Alva Edison Born 100 Years Ago 105

Additional Topping at Sherman Creek 108
By R. T. Roberts

Annual Meeting of the ASME 113
By Ralph E. Turner

Raw and Treated Water in TVA Hydroelectric Plants 124
By H. J. Petersen

News from the Field 126

Coming Events 126

Obituaries 142

Manufacturers' News 144

Manufacturers' Personals 150

New Engineering Books 152

Catalog Library 156

Construction News 172

Copyright, 1947, by Technical Publishing Company

50TH ANNIVERSARY

CELEBRATING 50 YEARS OF SERVICE TO THE POWER INDUSTRY

EDITORIAL STAFF

RALPH E. TURNER
Editor

ANDREW W. KRAMER
Managing Editor

CHESTER R. EARLE
Associate Editor

THOMAS E. HANSON
News Editor

RICHARD H. MORRIS
Engineering Editor
On leave with U.S. Army Air Forces

Published Monthly by
TECHNICAL PUBLISHING CO.
53 W. JACKSON BLVD.
CHICAGO 4, ILL.

KINGSLEY L. RICE, *President*
EDWIN C. PROUTY, *Vice President*
WALTER PAINTER, *Vice President*
ARTHUR L. RICE, JR. *Treasurer*
CHARLES S. CLARKE, *Secretary*
JOHN O. AARVOLD, *Prod. Mgr.*

ADVERTISING REPRESENTATIVES

CHICAGO: Charles S. Clarke
Arthur L. Rice, Jr.
53 W. Jackson Blvd., Chicago 4, Ill.
Harrison 0824

NEW YORK: Oscar Wilds
Graybar Bldg., New York 17, N.Y.
Caledonia 53779

PHILADELPHIA, PA.
Irwin F. Megargee
4817 Hazel Ave.
Philadelphia 43, Pa.
Sherwood 7-8349

CLEVELAND: A. H. Van Duyn
681 Union Commerce Bldg.
Cleveland 14, Ohio
Cherry 1377

PACIFIC COAST: Roy M. McDonald Co.
San Francisco: Roy M. McDonald, Mgr.
564 Market St.
San Francisco 4, Calif.
Garfield 8966
Los Angeles: Robert Aland, Mgr.
1323 Venice Blvd.
Los Angeles 6, Calif.
Drexel 2590
Seattle: Thomas L. Emory, Mgr.
1411 Fourth Ave.
Seattle 1, Wash.
Elliott 1370

Subscription Information—The monthly issues are sent prepaid by second class mail. Prices: United States and possessions one year $3.00 and two years $5.00. Canada one year $4.00 and two years $6.00. Pan American countries one year $5.00 and two years $8.00. Other countries one year $7.00 and two years $12.00. Address correspondence about subscriptions to Circulating Division, POWER PLANT ENGINEERING, 53 West Jackson Blvd., Chicago 4, Illinois. Changes of address should give both old and new address and reach us by 20th of month to be effective with following month's issue. The Annual Index is furnished as a part of the December issue.

Entered as second class matter September 8, 1922 (original entry May 1, 1908) at the Post Office, Chicago, Illinois under act of March 3, 1879. Additional entry at Ann Arbor, Mich.

Jenkins PRACTICAL PIPING LAYOUTS 19

How to plan BOILER FEED PUMP CONNECTIONS

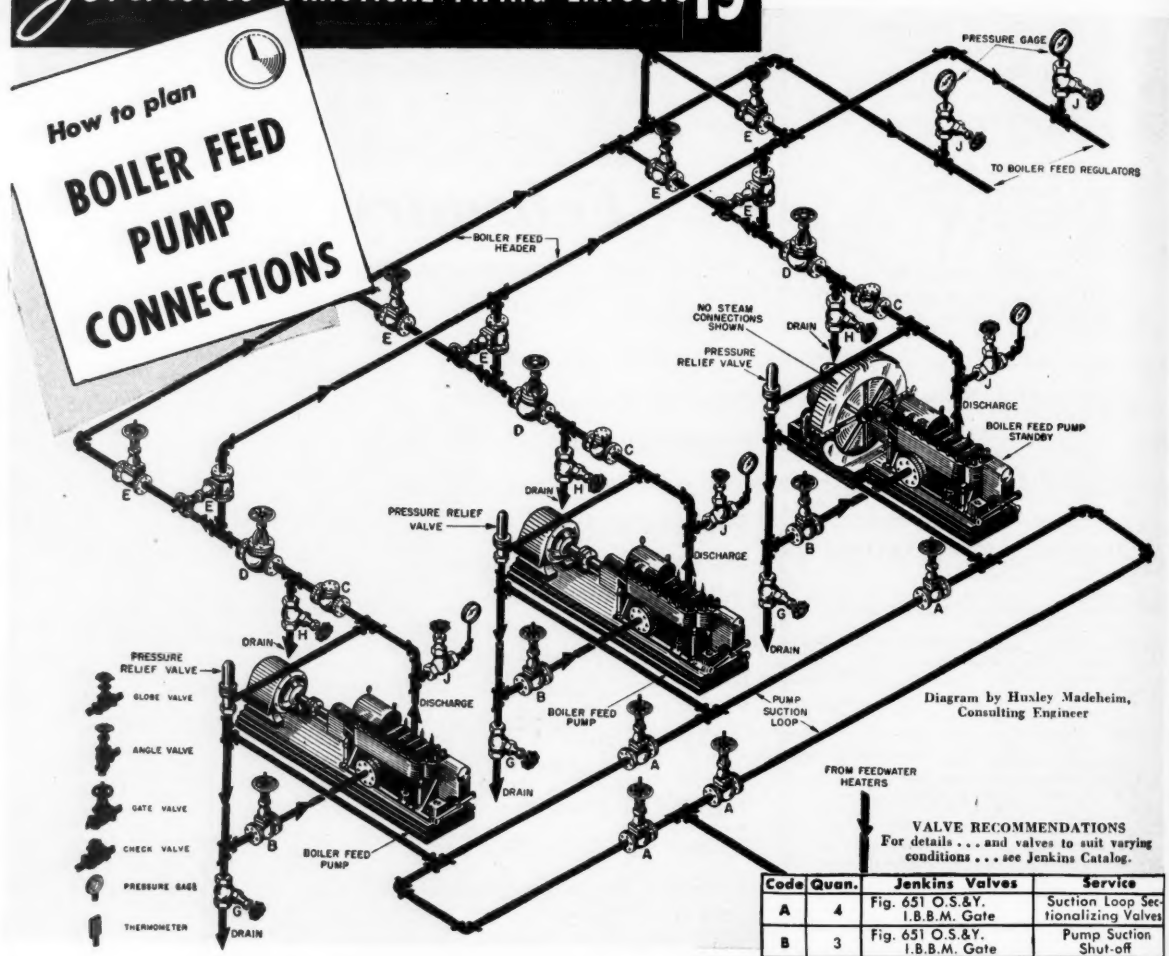


Diagram by Huxley Madeheim, Consulting Engineer

Typical equipment for boiler feed pumping connections on high pressure systems operating at less than 500 p.s.i. is shown in this layout.

Two pumps are normally required to handle the full capacity of the boilers, with one serving as a stand-by. Either pump may be connected to any one header with a tie between two headers.

The discharge from the feedwater heating equipment goes into a boiler feed suction loop which allows for segregation of feed to individual pumps and provides the insurance against failure of two independent feedwater lines.

Pressure relief valves on the pump discharges regulate discharge pressure at a constant value, despite fluctuations imposed on the system by the boiler feed regulators, without regulating pump speed. Drains are provided at the heels of the suction lines to the pumps and between the check and globe valves on the pump discharges.

Consultation with accredited piping engineers and contractors is recommended when planning any major piping installation.

Copies of Layout No. 19, enlarged, with additional information, will be sent on request . . . also future Piping Layouts. Just mail coupon.

A CHOICE OF OVER 600 JENKINS VALVES

To save time, to simplify planning, to get the advantage of Jenkins specialized engineering experience . . . select all the valves you need from the Jenkins line, fully described in the Jenkins Catalog. It's your best assurance *of the lowest cost in the long run.*

VALVE RECOMMENDATIONS
For details . . . and valves to suit varying conditions . . . see Jenkins Catalog.

Code	Quan.	Jenkins Valves	Service
A	4	Fig. 651 O.S.&Y. I.B.B.M. Gate	Suction Loop Sectionalizing Valves
B	3	Fig. 651 O.S.&Y. I.B.B.M. Gate	Pump Suction Shut-off
C	3	Fig. 339-R Iron Body Swing Check	Pump Discharge
D	3	Fig. 162 O.S.&Y. I.B.B.M. Globe	Pump Discharge
E	7	Fig. 204 O.S.&Y. I.B.B.M. Gate	Header Selection
G	3	Fig. 106A Bronze Globe	Suction Drain
H	3	Fig. 801 Bronze Globe	Discharge Drain
J	5	Fig 703 Bronze Needle	Pressure Gage Control

Jenkins Bros., 80 White St., New York 13; Bridgeport, Conn.: Atlanta; Boston; Philadelphia; Chicago; San Francisco; Jenkins Bros., Ltd., Montreal.

LOOK FOR THIS JENKINS TRADE MARK **DIAMOND MARK**
Since Jenkins Bros 1864

JENKINS VALVES

For every Industrial, Engineering, Marine, Plumbing-Heating Service . . . in Bronze, Iron, Cast Steel, and Corrosion-resisting Alloys . . . 125 to 600 lbs. pressure.

Sold Through Reliable Industrial Distributors Everywhere

JENKINS BROS., 80 White St., New York 13, N. Y.
Please send us a reprint of Piping Layout No. 19 and future Layouts as they become available.

Name .....
Address .....
Company .....

ENGINEERS' PREVIEW

THESE two regular pages were titled *Front Lines* when first established because we felt their purpose was primarily to provide news of technical and scientific developments that were right up in the front lines of the battle of industrial progress. The war was going on at that time, hence the title had an additional connotation. Moreover, they were in the front of the magazine. Now, however, it seems to us that a change of title would be beneficial to readers. *Front Lines* really doesn't mean much any more. The bulk of the material on these pages is intended to be a preview of industrial and scientific developments that are on the way. So why not call it by its right name? The material will be the same as before. Only the title is changed.

FACTORY SALES of mechanical coal stokers totaled 20,941 units of all sizes and types in August of last year compared with 11,021 machines for the same month in 1945, according to a U. S. Department of Commerce report based on information supplied by manufacturing establishments which represent virtually the total production of stokers in the United States. Sales for the January-August period last year totaled 127,348 units, with 60,175 machines for the corresponding period in 1945 and 22,596 stokers in 1944. Factory sales for the first eight months in 1946 also slightly exceeded the same period in 1941, which period accounted for total sales of 122,551 stokers. 1941 was the largest sales year in the industry. Sales of stokers for residential heating (up to 61 lbs. of coal per hour) for both bituminous and anthracite coals for the January-August period of 1946 totaled 114,648 units with 33,975 in the same time in 1945. Virtually all residential stokers as well as commercial and small industrial machines are of the underfeed type.

WITH USE of stainless steel steadily increasing in various applications, many problems in "joining" it have presented themselves to engineers and welders. The most common weld troubles encountered are:—1. Warping, distortion and stresses; 2. Scaling and oxidation, causing expensive after-treatments; 3. Welding light gages successfully—those not weldable by high heat methods; 4. Welding stainless steel to dissimilar metals, such as copper, bronze, monel, etc. A great deal of interesting information on the welding of stainless steel by low temperature methods, with tables of temperatures and data on applications, are given in Volume 4, No. 2 of *The Eutectic Welder*.

ALL POWER ENGINEERS at one time or another have to use rope, usually in some rigging operation such as those recently discussed in the Practical Engineer & Electrician Section by H. B. McDermid. In connection with those articles, readers may be interested in knowing something about how rope is made nowadays. As most people know, it was originally made by a very laborious manual process in which the workman wrapped a "strike" of clean straight hemp fibers around his waist and walked backward down a long corridor, permitting the fibers to play out freely. The free ends of the fibers were fastened to hooks on small revolving spindles, which gave the desired twist to the yarn as it took form under the manipulation of the spinner. Thus it is easy to see where the name "rope walk" came from. The name is still used but, of course, nowadays most rope is made on special twisting machinery, although a rope walk a quarter of a mile long, for the manufacture of large cables, is still in existence. A detailed and very well-illustrated description of modern processes of rope making is given in the July-August issue of *Oil-Power*, showing the various machines and steps in the processes. Chief of all fibers from which rope is made is manila hemp, which is not hemp at all, but is obtained from the stalk of a plant of the banana family. The second most widely used fiber is sisalana, the third is sisal or henequen. Other fibers are American grown hemp, New Zealand hemp from the fibers of a variety of lily, cotton, jute, Saran and Nylon. Rope for special purposes has even been made from glass fibers.

THE 6500-hp geared-steam-turbine locomotive, designed by engineers of Westinghouse, Baldwin, and the Pennsylvania Railroad in its road trials and shop tests met with marked success, it is announced. The next appearance of the steam turbine on rails will be the three turbine-electric locomotives for the Chesapeake and Ohio Railway. These locomotives are expected to enter service this year. Each of these locomotives has a single 6000-hp steam turbine geared to two direct-current generators, which supply power to eight axle-hung motors in the manner commonly employed with Diesel-electric locomotives. Studies have been made of a 9000-hp geared-turbine locomotive. This one will employ two 4500-hp steam turbines set longitudinal with the locomotive frame and each driving four axles through a longitudinal shaft and gearing instead of side rods. Also, studies are being made of the most appropriate boiler and steam conditions for use with a turbine.

FOR ANY ONE who wants to teach a course in physics to a group of men in an industrial plant, here is an idea that seems worth looking into. A number of carefully-selected and carefully-prepared experiments in physics have been written up and illustrated by a group of well-known professors of physics co-operating with the technical staff of Central Scientific Co. The manuscripts consist of either two or four pages, depending on the experiment and, in the case of one experiment, 8 pages. Now available are 135 experiments covering subjects in mechanics, heat, sound, light and electricity. They are loose-leaf in form, punched to fit the standard ring binder so that an up-to-date manual for every situation can be compiled. A selection of experiments can be made to fit the needs of the proposed course, the apparatus on hand, and for close coordination with any desired text book. The flexibility of this scheme seems to be entirely new in the field of laboratory instruction. It is designed to permit the instructor to develop the laboratory most suitably for his courses, while at the same time he is spared the laborious task of writing his own directions. Except for an 8-page experiment on Galvanometers which sells for 10 cents, the price for the two-page experiments is 3 cents per copy, and for the four-page 5 cents per copy. A mimeographed list indicating the subject matter covered by the experiments, also a couple of sample copies, can be obtained by those interested. Just drop us a line.

METHOD of measuring viscosities of liquids at high frequencies by means of oscillating cylinders, in which a torsionally vibrating crystal generates a viscous wave in the medium to be measured, was reported by W. P. Mason of Bell Telephone Laboratories before the 1946 Annual ASME Meeting. Both a reactance and a resistance loading occur in the crystal which lowers its frequency and raises the measured resistance at resonance. The viscosity may then be determined by measuring the changes in the properties of the crystal. By varying the voltage on the crystal, the shearing displacement can be varied, hence the viscosity can be measured as a function of shearing stress. Measurements on light oils over a viscosity range from 0.01 poise to 10 poises check within a few per cent when made with rough temperature-control conditions.

A NEW SOURCE of iron powder for powder metallurgy is promised by an unusual development in Northern Minnesota recently announced. Moreover it is to be produced by an unusual co-operative agreement under which an iron conversion plant is being built by the State of Minnesota at a cost of $650,000 and is to be operated by Continental Machines, Inc., a Minneapolis machine-tool manufacturing concern. As described recently in *Business Week*, the plant is designed to convert iron carbonate slate, heretofore a waste product, into pure iron powder.

AN OUTSTANDING development pioneered by International Nickel's research division and its Bayonne Works was the introduction of Ni-Rod, a new electrode for the making of machinable welds in cast iron. During 1946, as reported by R. C. Stanley, Chairman and President of the International Nickel Company of Canada, Ltd., operations were begun at the company's new precision casting plant at its Bayonne Works. This plant is now producing precision cast shapes in nickel, Inconel and Monel.

WHEN IS A NAIL not a nail? When it has the holding power of a screw. Such a nail is the Anchorfast, made with grooves so that, when it is driven into wood, the broken wood fibre locks into the grooves with a bear hug to give additional holding power. Tests made at the boat yards of Henry B. Nevins, Inc., showed that it takes 65 per cent more force to pull the Anchorfast than an unclinched galvanized nail—31 per cent more than to pull a clinched nail—19 per cent more than for a riveted copper nail. In addition, it had a 3 per cent edge over a wood screw of comparable size.

AN INTERESTING CONTRAST to the big pumps used in power plant and industrial work is the midget centrifugal pump now available for laboratory work, as described in a recent issue of Cenco News Chats. One model of this midget liquid circulating pump is a centrifugal unit with a maximum output of 4.5 gpm at zero pressure, maximum pressure at shut-off, 11 psi. It is driven by a 0.01-hp universal motor operating on 115 volts, 25 to 60 cycle a-c, or d-c. The price is $24.00 each. There is also another pump of slightly larger capacity, 6.5 gpm for 18 psi shut-off pressure, price $38.50. Sometime you might have to circulate a very small quantity of water at low pressure through a constant temperature bath or a small cooling device of some kind and one of these midget pumps might come in very handy.

DO YOU want to put some bolts into concrete? Then, just shoot them in. A new method does just this by means of a special gun which fires the projectile in the shape of a hardened steel point, the rear part having threads. It is claimed that the pulling force necessary to remove bolts mounted by this method is four times that of any other mounting.—*The Ohmite News.*

XUM

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail.

BOILERS, STOKERS

1 **Scotch Marine Boilers**—There are four pages in Bulletin B-3050 which is devoted to a description of the company's "Wee-Scot" Scotch marine boiler. The bulletin gives information on construction, capacity, standard equipment, ratings and also gives a large table of dimensions, ratings and volumes. This is accompanied by a dimensioned line drawing. A detailed line drawing of the boiler with labeled parts is printed. The Titusville Iron Works Co.

2 **Steam Generators**—The eight pages of this recently-issued bulletin describe and picture the company's line of steam generators from 10 to 300 hp. Pertinent details of the boilers' performance and construction are given and large, clear illustrations of the boilers appear. A full page of table and drawings give information on dimensions and sizes. Ames Iron Works.

3 **Furnace Wall Construction**—This six-page folder is really a treatise on furnace wall construction with special emphasis placed on the particular features of the company's "gravity-lock" construction. Exceptionally good line drawings are used for illustrative material and they clearly depict the points brought out in the description. Waite Construction Co.

4 **Chain Grate Stokers**—Stokers for anthracite, bituminous, coke breeze, lignite and mixtures are described in this 12-page bulletin. Efficiency and maintenance features of the stokers are followed by descriptions of the fuel grate operating mechanism, the coal hopper, link removing jack and chain grate links. The bulletin is well illustrated. The McClave Co.

AUXILIARIES

5 **Heat Exchangers, Preheaters, Condensers**—A series of seven catalog sheets has been issued by this manufacturer; they deal with various types of heat transfer equipment such as surface condensers, steam jet ejectors, heat exchangers, heaters and preheaters and coolers. Several of the bulletins describe more detailed catalogs which may also be sent for direct to the company. Each of the sheets is well illustrated. Ross Heater & Mfg. Co., Inc.

6 **Storage Tank Fabrication**—The eight pages of this bulletin are devoted to a description of the company's "vapor saving roofs" for the conservation of petroleum products. Tables and charts are presented to show losses in gallons (sometimes as high as 87,900 gal. per year) from conventionally constructed tanks. Detailed drawings, photographs and tables of capacities are given. Graver Tank & Mfg. Co., Inc.

7 **Heat Exchangers**—This company's "Aero" heat exchangers are described in Bulletin 96. The accurate, year 'round temperature control for the cooling of liquids or gases is stressed in the bulletin. One line drawing depicts the path of liquid or gas flow through the unit and an installation view also is presented. Operation is shown on a sectional, cut-away drawing which is accompanied by explanatory text. Niagara Blower Company.

COMPRESSORS, DRIVES

8 **Air and Gas Compressors**—Single horizontal compressors are dealt with in Bulletin L-640-B1A issued recently; there are 22 pages in the bulletin. Standard motor drive arrangements and optional drive arrangements are described and illustrated at the front of the bulletin. Installations of the equipment are shown and a well-executed drawing shows a typical arrangement of equipment. Points of superiority and descriptions of integral parts of the compressors are given. Worthington Pump & Machinery Corp.

9 **Packaged Power Unit**—This company's motorized hydraulic drive (Electrofluid) is described in a new 14-page catalog. The bulletin gives complete information on how the unit assures continuous trouble-free operation, how it is designed to prevent prolonged work stoppages and losses, how it saves money and provides easy installation. Excellent photos and drawings illustrate the principles of operation and tables of horsepower and torque ratings and dimensions give engineering information. Link-Belt Co.

ELECTRICAL

10 **Renewable Fuses**—This 8-page folder on the company's renewable fuses describes fuses for 250-v service from 3 to 60 amp up to 70 to 60 amp and with the same range in the 600 v sizes. One section of the folder points out why these fuses are exceptionally dependable with their higher lag on starting loads, great strength and durability. Ware Brothers.

11 **Electricians' Handbook**—This 78-page handbook, spirally bound in heavy paper, presents valuable information on E.M.T. bending, method of use, making accurate stubs, use in concrete, back-to-back bends, straightening and re-bending, true offsets, making saddle bends, how to saddle a beam, shifting stubs, making sharp radius bends, mandrel bends, correcting knocked-over stubs, tables of sizes. An extremely important part of the book is the "Supplementary Data." Typical of the material presented in this section: tables of current-carrying capacity of conductors, number of conductors in conduit or tubing, minimum foot candles for efficient lighting, industrial interiors illumination, graphical electrical symbols, voltage drop tables and "A Guide to Effective Electrical Maintenance." The handbook is exceptionally well illustrated. Republic Steel Corp.

12 **Motor Repair Equipment**—This new catalog, because of the great scarcity of motors and generators, should be of aid to the maintenance man. It is a 10-page job which illustrates and describes motor maintenance tools which are designed to conserve present equipment. It points out how, through proper maintenance care greater immediate efficiency is assured and preservation of present motors and generators will eliminate costly shut downs later. Some of the equipment described are: commutator and slip ring resurfacing stones, polishing stones, commutator saws and milling cutters, carbon brush seaters, etc. Holub Industries, Inc.

CONTROLS, INSTRUMENTS

13 **Instrument Data Book**—Data Book No. 1000 is entirely devoted to a discussion of the principle of pneumatic transmission in the company's flow, pressure, liquid level and density measuring instruments. Among the first principles discussed in the book are those of measurement and force balance. Performance features of the force balance principle and its construction are next considered. Other sections cover operating design and construction of differential pressure transmitters; also covered are the operating adaptability of these units, materials of construction, flow measurement and table of specifications. Pressure and density transmitters are dealt with in a like manner. The booklet is well illustrated and contains 28 pages. Republic Flow Meters Co.

14 **Safe Combustion**—Bulletin 604 describes and illustrates this new electronic combustion safeguard for oil, gas, pulverized coal burners. Integral parts of the control systems are pictured in the bulletin and brief descriptions of the part each plays in the assembly is pointed out in the accompanying text. The last page of this four-page folder presents six line drawings of hook-ups for the control system when various types of fuel are used. Combustion Control Corp.

15 **Industrial Instruments**—Among the items described and illustrated in this 20-page bulletin are recalibrators, pressure gages, vacuum gages, compound gages, altitude gages, hydraulic gages, ammonia gages and attachments. Tabulations accompany each description and give styles, sizes and ranges. Jas. P. Marsh Corp.

16 **Instruments**—Several instruments in the company's line are described and illustrated in this four-page folder. Included in the descriptions are tank depth gages, CO_2 indicators and recorders, draft gages, pressure and vacuum gages, vacuum recorder and combined barometer and vacuum recorder. Concise descriptions and listing of features accompanies each instrument. Uehling Instrument Co.

17 **Surface Pyrometers**—Bulletin 194-SA, 12 pgs., tells about the applications of these surface pyrometers for such uses as checking external temperature of insulated piping, checking temperatures of motors, etc. These applications and many others are described, the instruments are shown and their construction explained. The bulletin is well illustrated. Cambridge Instrument Co.

18 **Instruments Catalog**—This 12-page catalog C-11 describes and illustrates the company's line of instruments and presents prices of the different items. Included in the catalog are U-type manometers, well-type manometers, pressure gages, draft gages, flow meters, liquid level gages, sight feed bubblers and parts for many of the instruments. Tables of ranges for some of the instruments are presented. The booklet is well arranged for easy reference. The Meriam Instrument Co.

19 **Try Cocks Bulletin**—Bulletin F tells about the company's line of try cocks for all pressures. The types of try cocks range from the standard wood wheel bronze units for pressures up to 150 psi to the forged steel units for steam pressures up to 2500 psi. Complete descriptions of each are given and sectional drawings and photos illustrate the products. Tables of connections and types accompany each description. Ernst Water Column & Gage Co.

20 **Thermometers and Pressure Gages**—Catalog 6707, Thermometers and Pressure Gages, is an 18-page bulletin covering the company's line of instruments in this class. Detailed description of the design features of the unit are covered in the first several pages. Line drawings in black and color aid in the description. Descriptions and photos of each unit in the line are presented. Brown Instrument Co.

PIPE, FITTINGS, WASHERS

21 **Diesel Engine Welded Fittings**—This 32-page booklet covers the application of the company's welded fittings and flanges on Diesel engines. Application data, with working drawings, are presented on exhaust systems, air intake systers, air starting systems, lubricating oil sytsems, water cooling systems, fuel injection sytsems. Basic advantages of the fittings are first explained and then detailed descriptions of the fittings' uses on each of the above named systems are given. Tube Turns, Inc.

22 **Lock Washer Data Book**—"How, Why and Where of Lock Washers," is the title of this new bulletin. Some of the questions answered in the booklet are: What are the primary and second-

---

FEBRUARY

POWER PLANT ENGINEERING

Please have the manufacturers send me without obligation the literature indicated by the following paragraph numbers:

_____

_____

_____

_____

Your Name .....

Your Title .....

Name of Company .....

Company Address .....

City ..... State .....

(If you prefer delivery at your home address also fill in the following spaces.)

Home Address .....

City ..... State .....

DEPARTMENT OF TECHNOLOGY BUFFALO PUBLIC LIBRARY

ary zones of power in a fastening device? When should a spring lock washer be used? When should a lock nut be used with a spring lock washer? It is without a doubt one of the most complete books on this subject ever issued. Tables of specifications and standards are given. George K. Garrett Co.

23 **Forged Steel Fittings**—Volume 2, second edition of this engineering and technical data reference book on screwed and socket welding forged steel fittings has just been issued. It is a 44-page issue with a cellophane encased cover. Covered in the booklet are design and construction, service recommendations, tables of list prices and sizes for the various classes of fittings, manufacturing standards and material specifications. Other tabular material includes thread standards, tables of properties of pipe and four pages for calculating wall thickness and stress. Ladish Co.

24 **Steel Needle Valves**—Valves of stainless steel and carbon steel bar stock are described in this four-page bulletin. Outstanding features of the valves are described and line sketches illustrate the points mentioned. A listing of general specifications is given and two large tables of list prices and dimensions for the globe type and angle type valves are presented. Kerotest Mfg. Co.

25 **Insulated Pipe Units**—Specification data for engineers and architects are given in this recently issued 16-page catalog, Form 4626. The bulletin is exceptionally well illustrated with good line drawings and photos of installations under construction or already installed. Sample specifications cover four pages which are followed by illustrated tabular material on conduit systems. Full page expansion charts are next presented and these in turn are followed by detailed installation instructions and drawings. The Ric-wiL Co.

26 **Expansion Joints**—Bulletin XJ-300 is an eight-page booklet covering the company's slip type expansion joints. Applications, design features, standard construction and specifications are given. Full page tables of dimensions, pressures and pipe sizes are presented for the various types of expansion joints in the line. The booklet is illustrated with photos and line drawings. Howard Iron Works.

PACKING, GASKETS

27 **Gaskets Booklet**—The 32 pages in this recently-issued booklet on metal and asbestos gaskets contain not only information on the gaskets in the line but also several pages of engineering data and tables. The booklet is divided by gasket types such as spiral wound, ring type, sheet and stampings; these sections, in turn, are subdivided. Tables of specifications and drawings accompany each type of gasket. A specification record sheet and a specification blank for order or inquiry is printed. The engineering data tables include circumferences and areas of circles, steam tables, tables of water heads and equivalent pressures, conversion tables and formulas. United States Gasket Co.

28 **Packings Catalog**—As a convenient guide to its line of mechanical packings, this company has just issued a 20-page condensed catalog, PC-100. The catalog, printed in two colors, contains information on service applications as well as construction and performance features of the most widely used packings in the line. The catalog also contains the well-known "ABC Chart for Palmetto Self-Lubricating Packings." In addition to many other features the catalog presents 42 interesting illustrations. Greene, Tweed & Co.

PRIME MOVERS

29 **Turbines, Pumps, Products**—This 24-page catalog covers the company's complete line of products from steam turbines to flexible couplings. Each and every product is discussed from the design and operation angles and the discussion is heightened in interest by the inclusion of many excellent photographs. Some of the other products discussed are helical gears, centrifugal pumps, multistage pumps, screw pumps, blowers, compressors and speed reducers. De Laval Steam Turbine Co.

30 **Turbine Cleaning Manual**—This 20-page bulletin covers the step-by-step solvent and manual cleaning of turbines from the inspection and preliminary cleaning to draining and final inspection. The cleaning of bearings and governor, installation of filter unit, circulation of cleaning solvent, and displacement of cleaning oil with new lubricating oil are steps which are covered briefly but clearly. Excellent photographs are presented. Shell Oil Company, Inc.

31 **Sawmill Power**—"Profitable Power for Sawmills," is the title of a recently-issued 16-page booklet on Diesel power as it is employed in many sawmills throughout the country. Actual installation photos of the units in operation and presented and general figures regarding the savings made through their use are quoted. Caterpillar Tractor Co.

TREATMENT, CONDITIONING

32 **Fuel Oil Treatment**—This bulletin presents two highly informative sectional wash drawings of boilers and fuel oil systems. The first one shows what happens throughout the system, from the storage tank to the burners, when the company's fuel oil treatment is not used. The second illustration shows the reaction in these same spots when the treatment is used. Each point affected is pointed out and the causes and cures are explained. Instructions for application of the treatment are given on the last page. E. F. Drew & Co., Inc.

33 **Flow Responsive Equipment** — Automatic flow responsive equipment and methods for continuous treating, sampling, blending, diluting in process operations are covered in this recently-issued 28-page Bulletin 1200. Various arrangements of the equipment for treating, sampling, etc. are shown in excellent two-color diagrams and the arrangements are explained in accompanying text. The entire booklet is helpful in its description of operation, installation and selection and several selection tables and explanations make the choice of the system are given. Proportioneers, Inc.
of proper unit easy. Descriptions of integral parts

34 **Water Conditioning Instruction Booklet**—This 12-page instruction booklet, 28X6385, titled "Allis-Chalmers Water Conditioning Chemicals and Equipment," written especially for the guidance of power plant operators. The booklet touches upon the importance of feedwater control, the care of testing equipment, obtaining samples, test procedures. Handy reference tables are also printed to assist in reporting results. A range of services available is also included. Allis-Chalmers Mfg. Co.

35 **Complete Water Conditioning Service**—This four-page bulletin describes this company's complete water conditioning service—analysis, design, fabrication, installation and maintenance of water treating equipment. Typical installations are pictured and brief sketches of the men behind the service are given. Graver Tank & Mfg. Co., Inc.

36 **Water Conditioning Handbook**—The most advanced and modern methods and apparatus for conditioning water and other liquids are described in this recently-issued 60-page booklet, Catalog G. The booklet describes the many different types of water conditioning processes and explains the applications, advantages and limitations of each type. Included in the material specially prepared for the bulletin are tables listing the various kinds of gaseous and solid impurities, showing the effects, limits of tolerance for various purposes, methods of removal and residual amounts of each impurity after treatment. A comparison chart showing the chemical results produced by various water treatment methods is also given. More than three dozen illustrations are used to show principles of operation and construction. Tables and charts add further to the usefulness of the booklet. Write on company letterhead direct to Liquid Conditioning Corp., 423 W. 126 St., New York 27, N.Y., for your copy of Catalog G.

37 **Water De-Ionizer**—Here is a four-page bulletin telling about the company's "Chem-Pure" de-ionizer for producing a pure water which may be used to replace distilled water for practically all laboratory and full-scale production uses. Principles of operation of the unit are explained and a chart to enable determination of costs is included. Condensed information on specifications, construction, prices, space required, etc., is given. Process Equipment Corp.

38 **De-Ionized Water**—Units having flow rates up to 500,000 gph are described in this bulletin on water de-ionizing equipment. Advantages of de-ionizing are explained and many photos and line drawings are used to illustrate the bulletin. Results of de-ionizing are shown in tabular form. Illinois Water Treatment Co.

MISCELLANEOUS

39 **Water Cooling Towers**—Catalog No. 145 contains 20 pages and gives extensive information on design, construction and operation of the company's line of water cooling towers. Sectional views of the towers show the water distribution system and the drift eliminator operating principle. A section of "Engineering Considerations" presents information on the reasons for the particular design and also shows construction details. A relative humidity chart is among the line drawings in the booklet. Typical installations are pictured. C. H. Wheeler Mfg. Co.

40 **Hand Cutting Stainless Steel**—Stainless and stainless clad and alloy steels, aluminum, bronzes and brasses, cast iron, Inconel and nickel can all be cut by hand using this recently developed method. The process, known as the Arcos Oxyarc Process, achieves the cutting by the combination of an electric arc and a stream of oxygen. The equipment and the process are described in a recently issued bulletin released by the company. One of the illustrations shows the specially designed Oxyarc holder and a tubular coated Oxycuttend rod which is consumed in the process of cutting. It points out that the process can be used wherever an a-c or d-c welder and bottled oxygen are available. The "knack" of cutting with this method can be acquired in less than an hour's time. The equipment, it is pointed out, is low in cost. Arcos Corp.

41 **Steam Traps**—This is a veritable manual on steam trap practice. Bulletin T-1739 contains 16 pages and presents excellent line drawings which depict the construction of the trap, its operation and installation. Tables of steam properties, dimensions of standard wrought iron pipe and sizes of traps for unit heaters are presented. One complete section is titled, "How to Figure Sizes of Traps." Additional applications and "Installation and Operating Suggestions," are two other important sections. Chapters on capacities and prices and weights, and dimensions include tables of capacities, weights and prices and also dimensioned line drawings. Yarnall-Waring Co.

42 **Tube Expanders**—This bulletin is completely filled with information on the company's line of tube expanders. It presents illustrations, tables of sizes for each type of expander and tells the uses for which it was specifically designed. A feature of the booklet is a full page table of nominal inside diameters of boiler tubes with OD's from ⅜ to 5 in. and gauges from 8 to 20. Richard Dudgeon, Inc.

43 **Oil Products for Industry**—Cutting oil, processing oils, general lubricants, refrigeration oils, Diesel oils, solvents, greases and waxes are among the petroleum products for industry which are described in this four-page folder. The various grades of each oil are analyzed and the reasons why they are fitted to each particular job are given. Sun Oil Co.

44 **Speed Selector**—This bulletin, four pages, describes this recently-developed speed selector; one section of the bulletin tells what the speed selector is and another section tells how it

(*Continued on Page 154*)

FIRST CLASS
PERMIT NO. 353
Sec. 510, P. L. & R.
CHICAGO, ILL.

BUSINESS REPLY CARD
No Postage Stamp Necessary if Mailed in the United States

POSTAGE WILL BE PAID BY—

POWER PLANT ENGINEERING

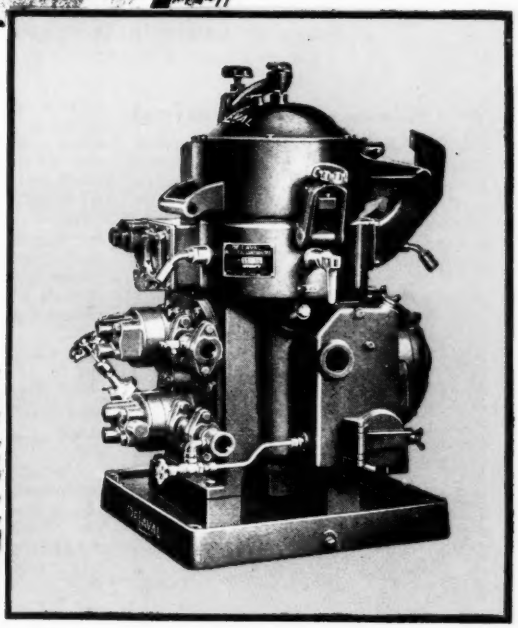
53 West Jackson Boulevard

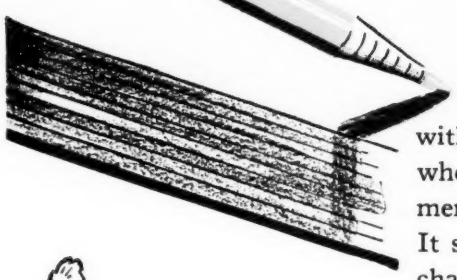
Reader Service Dept. Chicago 4, Illinois

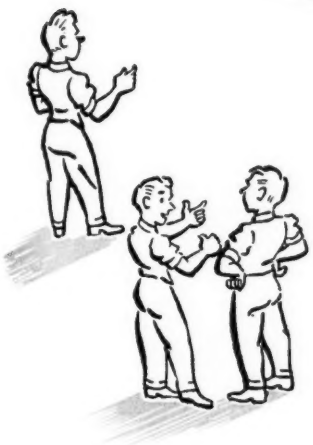
MEMO

When you spend money for a Turbine Oil Purifier - Get a Centrifugal Machine-

IT REMOVES WATER AS WELL AS DIRT!







Consider the advantages of providing your power unit with a De Laval Oil Purifier. The Purifier is a machine wholly mechanical in action. It requires no periodic replacement of functional parts to maintain its working efficiency. It separates out dirt from the oil instantaneously and discharges the clean oil continuously.

And It Removes Water Continuously at the same time. This is of great importance in the purification of turbine oils, for water in turbine oil is a prime source of sludge formation. And should a sudden water leak occur, really serious damage through emulsification will be prevented by the Oil Purifier. A De Laval unit of proper size has ample capacity to remove sudden "slugs" of water.

That is complete protection—removal of dirt ***and*** water. Since protection costs a fraction of what trouble does, why be satisfied with anything less than the best?

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 19
THE DE LAVAL COMPANY, Limited
MONTREAL PETERBOROUGH WINNIPEG VANCOUVER

DE LAVAL

LUBRICATING OIL PURIFIERS

NEW EQUIPMENT NEWS

Use the coupon below when you want further information on the equipment described on this page and following pages. Write the identifying letter or letters in the space provided, clip the coupon and send it to Power Plant Engineering, 53 W. Jackson Blvd., Chicago 4, Illinois.

A Micromet Chemical Feeders For a commercial, institutional or industrial establishment having corrosion or scale water troubles in hot water or cooling water systems—whether it uses 13 000 or 1.000.000 gallons per month—Calgon, Inc. has developed a new series of Micromet feeders by which

the chemical can be fed into the water lines with simplicity and low cost.

The feeders comprise an extension of the first Micromet feeder, developed last year for domestic use. The new series consists of large-type feeders holding up to 20, 50 or 100 lb of Micromet at one charge. The chemical dissolves slowly, rate 25 per cent per month, so that only that much of the initial charge needs to be renewed each month.

The amount of chemical required—and the size of the feeder—depend on the type of water trouble encountered and the amount of water to be treated. For corrosion the 50-pound feeder, for example, will handle up to 150.000 gallons of water per month. For hard waters producing lime scale it will handle up to 300.000 gallons. The larger feeder will handle up to 1.000,-000 gallons of scale-producing water per month. The smaller type feeders will handle as low as 3,000 gallons per month.

The feeders are simple in design, inexpensive and have no upkeep cost.

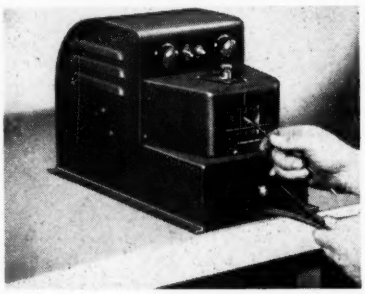
The Micromet water treatment, which inhibits scale and corrosion without attempting to soften the water fully, is thus made available to all types of commercial and industrial establi-hments—hotels, hospitals, restaurants, dairy plants, textile and leather plants, schools, colleges, many types of manufacturing plants. laundries, office buildings—in fact, wherever hot water or cooling water systems are a problem. Micromet also is of value in air-conditioning systems where evaporative condensers and coolers tend to scale up or corrode.

B "Hot Blade" Wire Stripper A new "Hot Blade" wire stripper for continuous production stripping is announced by Ideal Industries, Inc.

Through use of two electrically heated stripping blades, the unit will strip cotton, silk, synthetic (plastic) insulation or rubber covering from fine stranded or solid conductors. There is no possibility of cutting strands, nicking, scraping or injuring wire in any way, for the blunt blades cannot harm the finest wire.

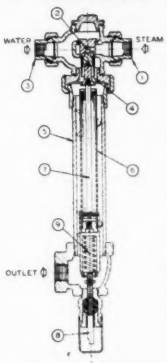
Operation is very simple. When a wire is inserted between the special heat resistant blades and foot pedal is depressed, two parallel grooves are instantly burned through the insulation, down to the conductor. A slight twist completes the groove and a pull removes the insulation—leaving a clean edge. A built-in exhaust draws smoke and fumes of burning insulation away from blades. The strippings fall into a water drawer where any burning particles are quickly extinguished.

Since different wire insulations strip



differently, each blade has an individual heat control and transformer to permit raising or lowering the burning temperatures as required for the particular insulation. A "Hi-Lo" switch, mounted between the blade controls, controls the adjustment of heat for heavy, average, and light insulation. The blades may be set at exact wire diameters, and an easily adjustable stop controls the length of stripping. This stripper is easily installed on present production line bench or table. 115 volt, 50-60 cycle standard, other voltages and frequencies available.

C Steam and Water Mixer To provide hot water at remote points for showers and wash basins is one of the ever present nuisance-problems of the larger factories and mills. This company suggests that you simply tap in on a steam pipe with Sarco Co's. new steam and water mixer. Designated to eliminate the necessity of piping hot water long distances or installing separate water heaters and temperature regulators at isolated points.



The smallest washroom can easily house this steam and water mixer, streamlined to a bare 26 in. length, 5 in. width at the head.

The thermostat, built-in and Sarco liquid-filled, insures automatic, sensitive temperature control, as set by key. Hot water capacities are surprisingly large; for example—200 gal per hr, temperature rise of 50 to 120 F, with a steam pressure of 75 psi. Foolproof construction, carefully designed and precision-made to obviate annoying shutdowns.

Steam enters at 1, goes through valve 2. Cold water enters at 3, mixes with steam in injection chamber 4. Resulting mixture of hot water enters housing 5, flows over thermostat 6 which is filled with Sarco liquid and hermetically sealed. When the hot water flows over it. this liquid expands, gradually pushing forward plunger 7 to close valve 2 and to cut off steam at temperature set at 8 by key furnished.

Body 5 then cools by radiation, liquid in thermostat 6 contracts and plunger head 7 opens valve 2. In operation, a balance is secured which holds valve open just sufficiently to maintain the desired temperature. Relief spring 9 prevents damage from accidental overheating.

Entire construction is brass with renewable valve heads and seats of stainless steel. Union connection on steam and water inlets.

Maximum steam pressure 125 psig; steam pressure must be 20 per cent higher than water pressure.

FEBRUARY, 1947

POWER PLANT ENGINEERING

53 W. Jackson Blvd., Chicago 4, Illinois

Please have the manufacturers send me without obligation further information on the equipment indicated by the following letters:

.....
.....
.....
.....
.....

Please Print Clearly

Your Name .....

Your Title .....

Your Company Name .....

Company Address .....

City ..... State .....

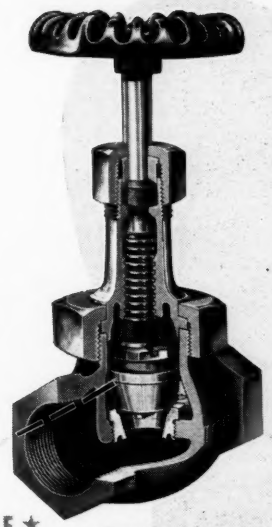
(If you prefer delivery at your home also fill in below)

Home Address .....

City ..... State .....

DEPARTMENT OF TECHNOLOGY BUFFALO PUBLIC LIBRARY

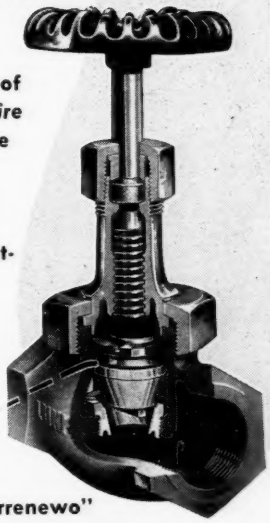
Here's all you need... to convert a regular type into a plug type valve...



BRONZE "RENEWO" VALVES

REGULAR TYPE
Fig. 73....200 lb. S.P.
Fig. 16....300 lb. S.P.

PLUG TYPE
Fig. 73-P..200 lb. S.P.
Fig. 16-P..300 lb. S.P.



IRON BODY "FERRENEWO" VALVES

REGULAR TYPE
Fig. 1021...150 lb. S.P.

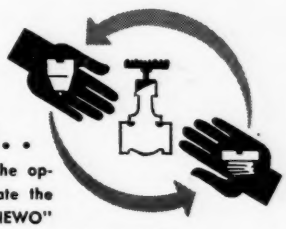
PLUG TYPE
Fig. 1021-P.150 lb. S.P.

SEATS AND DISCS INTERCHANGEABLE ★

Just insert a plug type seat and disc in place of the regular type, and you change an *entire* Bronze "Renewo" Valve from regular to plug type—providing all the extra advantages of this type, including its ability to stand up under unusually hard service. *No* other change is necessary. The plug type seat-and-disc combination is made to *fit perfectly* into a regular type valve of corresponding size and pattern. And you have this same interchangeability in Iron Body "Ferrenewo" Valves. You don't have to buy an entire new valve . . . you don't even have to take the valve out of the line.

*Lunkenheimer interchangeability goes still farther. *All parts* of 200 lb. "Renewo" and 150 lb. "Ferrenewo" Valves (except bodies and bonnet rings) are quickly, easily, perfectly interchangeable. Fewer parts are needed; ordering and handling are simplified; repairs are facilitated. You save time, labor, money.

Write for a copy of Circular 567—



LET YOUR LUNKENHEIMER DISTRIBUTOR DEMONSTRATE . .

Your nearby Lunkenheimer Distributor will welcome the opportunity to show you actual samples and demonstrate the interchangeability of parts in "RENEWO" and "FERRENEWO" Valves. You'll find it a big factor in increasing efficiency, lowering costs.

THE LUNKENHEIMER COMPANY

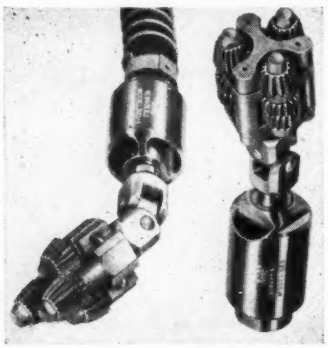
CINCINNATI 14, OHIO, U. S. A.
NEW YORK 13, CHICAGO 6, BOSTON 10, PHILADELPHIA 7.
EXPORT DEPARTMENT: 319-322 HUDSON ST., NEW YORK 13, N. Y.

D Jet Motors for Tube Cleaners Two new jet motors for tube cleaning, said to be the most powerful and efficient ever built, have been announced by the Elliott Co. Roto Division. The new motors, called the Roto Air Jet and the Roto Water Jet, driven by air and water respectively, were developed after extensive aerodynamic and hydrodynamic research. The Air Jet motor can be adapted to operate with steam. The water jet unit is shown at the left in the illustration; the air jet at the right.

According to the company's laboratory and field test data, the power developed by the new Air Jet Motor is so much greater than is required or desired for ordinary tube cleaning applications, that commercial models have been throttled down to operate at only a fraction of their potential power. Yet they develop from 100 per cent to over 250 per cent more power than previous Roto motors, the larger sizes showing the greatest increases. Air consumption per horsepower has been reduced 60 per cent to 80 per cent.

The Roto Air Jet Motor is extremely simple, having only two moving parts, a shaft and a blade. The Rotocentric (egg-shape) bore in the cylinder assures close contact between both opposite edges of the blade and cylinder at all times, permitting minimum air leakage and maximum utilization of air.

The Roto Water Jet Motor, although

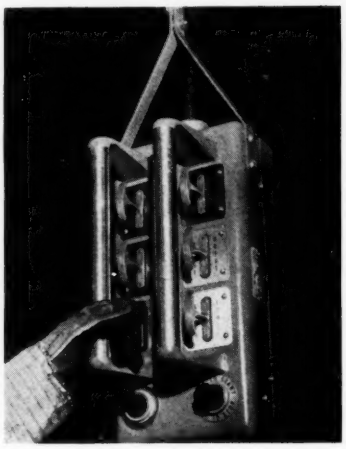


less powerful than the Roto Air Jet, represents an important advance in water-driven tube cleaners. A radical design change in the turbine wheel and other parts resulted in the production of what is claimed to be the most powerful and economical water-driven tube cleaner ever built. Power has been increased more than 100 per cent and water consumption per horsepower has been reduced 80 per cent on one of the smaller models.

Existing Roto cutter heads and operating hose will fit the new jet motors. Roto Air Jet and Water Jet motors are available for most common tube sizes, and other sizes are being added rapidly.

E Crane Control A pendant pull station control, a completely new system of control designed specifically for floor-operated cranes, has been announced by the Control Division of the General Electric Co. Furnished for use on alternating or direct current with motors up to 15 hp at 220 v the new control system can be used on cranes ranging in size from simple hoists to three-motion bridges, providing them with the same smooth operation and control refinements as cab-operated cranes.

The new control system consists of a small magnetic control panel mounted on the crane and connected by a cable to a pendant station which is suspended from the crane. It provides five-point, time-delay speed control for smooth, fast control of the crane movements. Because time-delay acceleration is provided in the pendant pull station, accelerating relays



usually found on magnetic control panels are unnecessary, and therefore the size of the control panel is reduced.

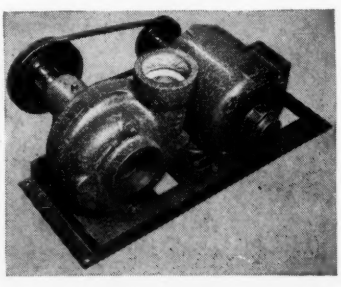
The pendant station has one handle for each direction of crane motion. To operate a particular crane motor or crane motion, the corresponding handle is pulled. As the handle is pulled out, the crane motor accelerates to the speed indicated by the position of the handle in the operator's fingers. All crane motions can be controlled with one hand.

Several protective features are included in the new system, such as an emergency stop button which instantly cuts off the power from all crane motors. Operation cannot be resumed until this stop button is manually restored to the "on" position and the momentary-contact, reset button is depressed.

F Pedestal-Type Pumps The Allis-Chalmers Mfg. Co. announces a new line of "Pedrifugal" pumps to meet the needs of an unusually wide range of users who require a sturdy, reliable pump of moderate capacity selling at a competitive price.

This new line of cast iron bronze-fitted, pedestal-type centrifugal pumps comes in three principal sizes—1 in. by 1 in.; 2 in. by 2 in. and 3 in. by 3 in. Capacities are from 10 to 500 gpm at heads from 10 to 100 ft, with power requirements from one-quarter to 15 hp. The units are splatter-finished with gray enamel.

"Pedrifugal" pumps are expressly designed for use with Texrope V-belt drives, giving an infinite range of capacities regulated by size of sheaves and power supplied. All the pumps are fitted with impellers of maximum diameter, and variations in capacity are provided by changes in speed through sheaves of larger or smaller diameter.



Small and compactly designed, all sizes of the pumps have essentially the same dimensions. This compactness, together with the fact that the pumps operate in any position, makes the unit well suited to designers of large Diesels, machine tools, air conditioners, heat exchangers.

G Recording Rotameter The combined engineering staffs of Schutte & Koerting Co. and Foxboro Co. have perfected a new type of recording rotameter utilizing the Dynalog (Foxboro Co.) system of transmission by electronic high frequency circuits. The recording system used on the recording rotameter, is based on the induction bridge system and makes available many new features for rotameter application.

With the new recording rotameter and the electronic Dynalog recorder great speed can be obtained, it is reported. Instantaneous response to change of flow, continuous balance, rugged power, continuous connections, unit construction using four principal assemblies, direct linkage with no gears, positive linear motion, long life and elimination of overtravel are features of this system.

This induction transmittor is now available for recording the rotor positions of many standard SK Rotameter designs, including the SK Universal Rotameter, the SK Armored Rotameter and others.

H Large Cooling Radiators A series of new type large capacity cooling and condensing radiators designated as VAD units has been announced by the Young Radiator Co.

The series ranges from the VAD-10, illustrated, to the larger VAD-16 with capacities for the water cooling unit ranging upward from 3,600,000 Btu per hr at standard conditions. The cooling faces are located on two opposite sides of the unit to permit line installation of several units where very large capacities are required, with no loss in efficiency or cooling faces blanketed off. Testimony for the versatility of the VAD design is brought out by their availability for water cooling, oil cooling, steam and vapor condensing, gas cooling or in combination arrangements to handle two or more types of service.

Following are some of the distinctive design developments incorporated into the VAD Units: Vertical air discharge with an induced draft fan to obtain more even air distribution and eliminate recirculation and cross wind effects; low speed fan for high efficiency operation with minimum horsepower costs; coils mounted in a vertical plane for economical installation, easy

Easier way to better piping ...CRANE Supplies Everything

Why do it the hard way when you can simplify every step of piping jobs—from design to erection to maintenance work. Specify Crane equipment—the truly complete line that not only includes everything you need, but assures the quality you want in every item.

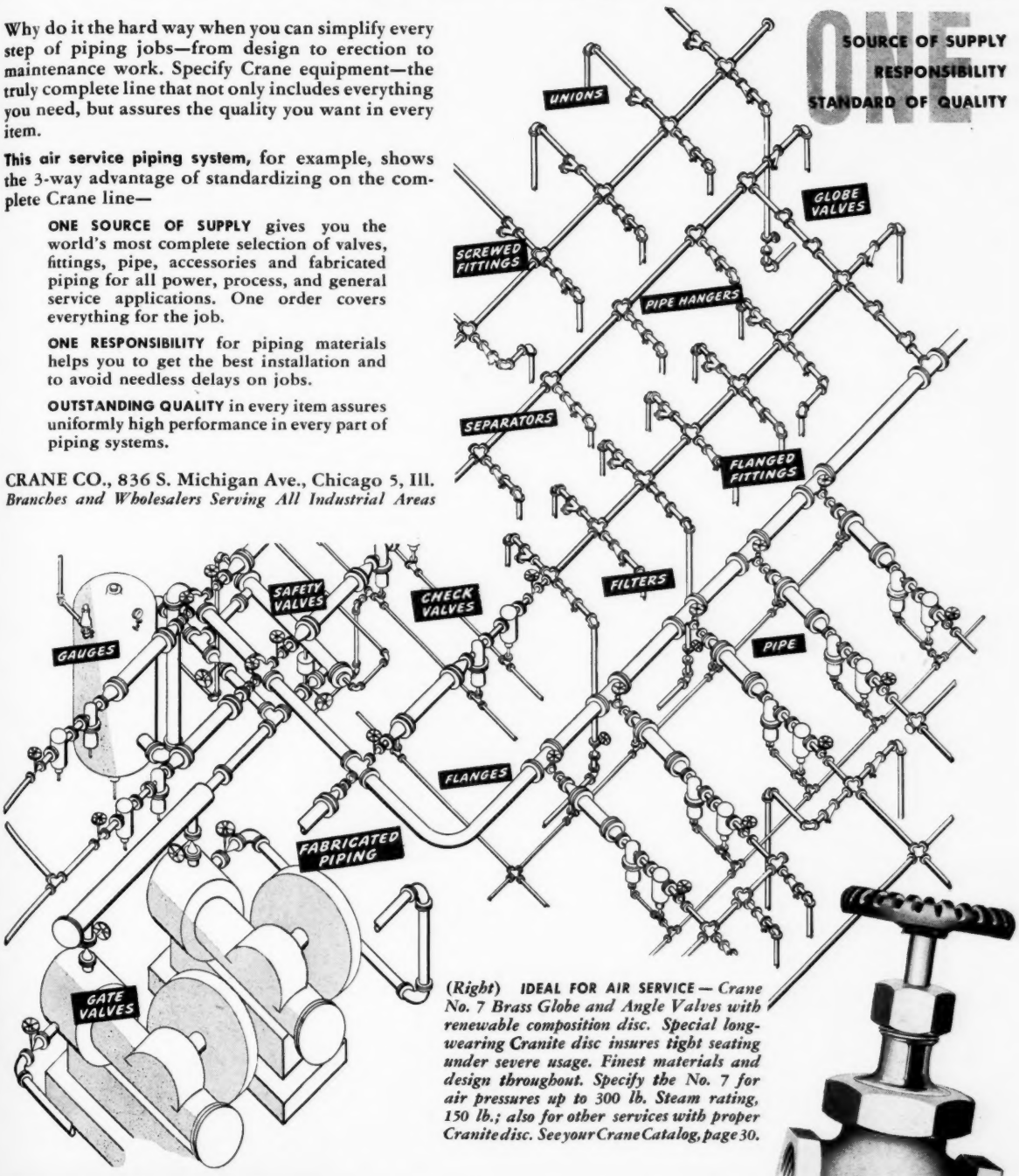
This air service piping system, for example, shows the 3-way advantage of standardizing on the complete Crane line—

ONE SOURCE OF SUPPLY gives you the world's most complete selection of valves, fittings, pipe, accessories and fabricated piping for all power, process, and general service applications. One order covers everything for the job.

ONE RESPONSIBILITY for piping materials helps you to get the best installation and to avoid needless delays on jobs.

OUTSTANDING QUALITY in every item assures uniformly high performance in every part of piping systems.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas



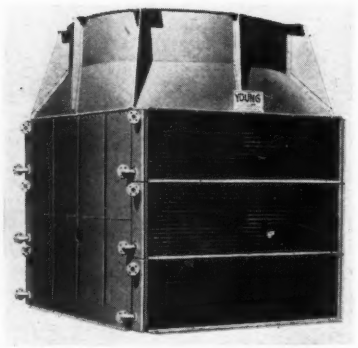
(Right) **IDEAL FOR AIR SERVICE** — *Crane No. 7 Brass Globe and Angle Valves with renewable composition disc. Special long-wearing Cranite disc insures tight seating under severe usage. Finest materials and design throughout. Specify the No. 7 for air pressures up to 300 lb. Steam rating, 150 lb.; also for other services with proper Cranite disc. See your Crane Catalog, page 30.*

EVERYTHING FROM . . .

VALVES • FITTINGS
PIPE • PLUMBING
HEATING • PUMPS

CRANE

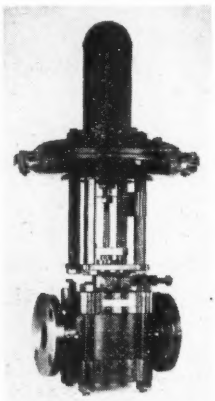
FOR EVERY PIPING SYSTEM



maintenance and maximum protection from the elements; simplified manifolding to supply and return lines; tube and fin coils with heavy wall round tubes for long and reliable service—removable end plates on water coils for quick and easy access to tube headers for inspection and cleaning; Fan and drive assembly mounted independent of main unit assembly, thereby eliminating the transmission of any vibrations from moving to non-moving parts; low level mounting and simplified foundation design for utmost accessibility to all components.

J Diaphragm Motor Valve A totally new design in diaphragm motor valve construction has recently been announced by the Fischer & Porter Co.. These valves are to be known as "The Valvrator Line" and as the name implies, it is an outgrowth of the recording-controlling Flowrator instrument (an area type flow rate meter which heretofore has been the principal product of the Fischer & Porter Co.).

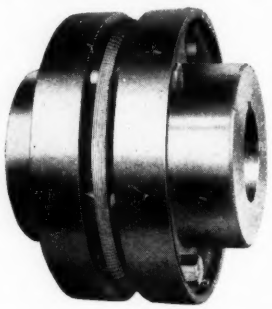
Chemical service applications have usually highlighted the Flowrator instrument; so valves suitably constructed for similarly difficult conditions have been a natural outgrowth.



Several unique design features have been incorporated in this new valve. Outstanding among these is the dished-bonnet construction with flush-seated bodies and through-bolts. No bonnet flanges are included in the body construction . . . and the design results in a compact unit with the lowest possible weight, greatly simplified cleanout characteristics and the possibility for fabrication in nearly all corrosion resisting materials. Body materials such as iron, bronze, stainless steel, carbon steel, hard lead, haveg, hard rubber, monel, nickel, hastelloy and even porcelain are regularly available.

The valve is made only in 150 lb construction in sizes from ¼ in. to 1 in. screwed, and from 1 in. to 3 in. flanged.

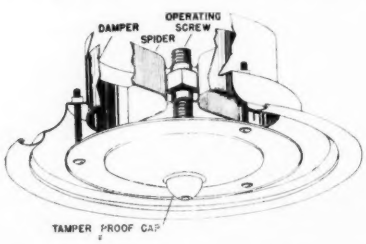
K New Flexible Coupling The ST Coupling announced recently by Thomas Flexible Coupling Co. is a single type which will take care of angular misalignment only and should not be used where each connected machine has two bearings. It was designed principally for use with outboard bearings or their equivalent. The coupling is self-aligning, self-supporting, maintains exact inter-relationship of the connecting shafts, and is so designed that it will support the armature or rotor of motors and generators, thus eliminating one bearing. A safety feature is provided which will prevent the dropping of the armature or rotor in case of an accident from overstress.



Some of the advantages of the ST-Type Coupling are savings resulting: (*a*) from shorter bed plate, (b) less floor space, (c) costs of one bearing.

L New Damper Construction This cut-away view illustrates the new, simplified, lightweight construction of the air volume damper, a standard feature accessory of Kno-Draft High Velocity Air Diffusers. The number of parts have been reduced and aluminum construction adopted throughout, lessening weight and increasing efficiency without sacrificing ruggedness and dependability.

The cylindrical damper is raised or lowered by turning the extended shank of the operating screw, centered in the lower cone and concealed by the Tamper-Proof Cap.



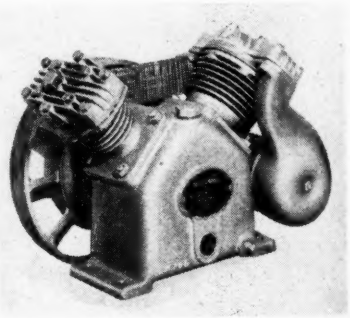
Any air volume may thus be quickly and easily obtained, providing the flexibility which is an important factor in rapid system balancing. As the damper is an integral part of the diffuser, no additional installation time is required on the job. The damper operates independently of the lower cone which is dropped or raised to adjust the air flow direction. It is announced by W. B. Connor Engrg. Corp.

M New Soot Remover O'Burnit, a recently developed chemical soot remover, brings a new order of effectiveness in cleaning oil or coal fired marine and industrial boilers. Formulated after intensive research and experiments, O'Burnit lowers the ignition point of both caked and loose soot to permit burning and supplies ample oxygen to support combustion. Tests show that soot along the entire path of passage is consistently removed. It is announced by O'Brien Industries.

O'Burnit is made of six chemicals properly proportioned to obtain superior results. There is nothing secret about the ingredients—no magic properties are claimed for it. Tests indicate that soot deposits, which act as an insulator on heating surfaces, are removed economically by O'Burnit with resultant increase in boiler efficiency. Use of soot blowers is reduced to a minimum.

A convenient feeder is supplied with an order of 1000 lb or more. Instructions for proper use are provided.

N Air Compressors A new line of air compressors, the first such line ever to be designed around established motor horsepowers, has been announced by Worthington Pump and Machinery Corp. Designated as the "Air-King," this line includes single-stage and two-stage sizes for pressures up to 250 psi for mating to standard motors of 1 to 15 hp inclusive. Arrangements include self-contained power driven models mounted on bases or tanks as well as bare compressors for either direct or V-belt connection to drivers. Such compressors supply air for a wide variety of industrial uses such as paint-spraying, operating pneumatic controls, tools, devices, etc.



The line also introduces an entirely new principle in automatic starting of compressors. A centrifugal clutch permits the driving motor to attain full speed before the compressor turns. This eliminates the need for starting unloaders, check valves, release and bleeder valves, etc. Direct power drive eliminates transmission losses and drive adjustments. It provides simplicity and compactness, at the same time resulting in neat, attractive appearance. An adequate guard incloses all moving parts assuring safety and cleanliness.

O Blasting Machine The Vacu-Blaster, an entirely new blast-cleaning device for cleaning or refinishing metal, concrete, or other hard surfaces, is now in production by the Vacu-Blast Co., Inc.

Unique feature of the Vacu-Blast is its vacuum return system, which permits no abrasives or other particles to escape into the open. It now becomes possible to blast-clean under conditions that once would

One Minute to learn the facts

About this big advance in water softening

THE IMPROVED ELGIN GIVES 44% MORE SOFT WATER

Here are all the facts

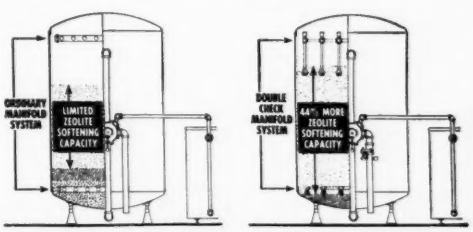
This new bulletin should be read by *all* soft water users. It's a factual presentation of this improved Elgin design, shows how a new standard of softener performance at reduced cost has been achieved. Ask for Bulletin 607. For hospitals, request Bulletin 608. For laundries, ask for Bulletin 609.

- ***What is this improved Water Softener?***

  The Elgin Water Softener is a truly revolutionary development which, size for size, delivers up to 44% more soft water than ordinary zeolite water softeners.

- ***How is its greater capacity obtained?***

  By an ingenious arrangement called the Double Check Manifold system. It permits a deeper water softening bed and at the same time prevents escape of zeolite. The larger zeolite bed, along with increased efficiency achieved by better distribution and more effective backwashing, gives this greater capacity. The diagrams tell the story.


ORDINARY MANIFOLD SYSTEM
LIMITED ZEOLITE SOFTENING CAPACITY
DOUBLE CHECK MANIFOLD SYSTEM
44% MORE ZEOLITE SOFTENING CAPACITY

ORDINARY WATER SOFTENER DESIGN — **ELGIN WATER SOFTENER DESIGN**

- ***What about investment cost?***

  It's soft water you really buy. The Elgin meets your needs with a smaller unit, and therefore a smaller investment.

- ***How about operating and maintenance costs?***

  Substantially reduced, for three important reasons. First, the Double Check Manifold provides more thorough backwashing, requires less regenerating salt and wash water. Second, the zeolite is kept clean and active for more efficient operation and longer life. Third, since escape of zeolite is mechanically barred, no costly periodic zeolite additions are necessary.

Any make of zeolite water softener can be modernized this Elgin way at surprisingly low cost. Remember, however, Elgin alone offers this ingenious development with its many important advantages that no other water softener can match.

ELGIN SOFTENER CORPORATION

136 N. GROVE AVENUE, ELGIN, ILLINOIS

SOFTENERS ★ FILTERS ★ WATER TREATMENT ★ BOILER WATER CONDITIONING

have prohibited the use of this effective means of removing corrosion, paint, stains, and other deposits.

Operated in much the same fashion as a simple household vacuum cleaner, the Vacu-Blaster may be used without special precautions or preparations. No masks, goggles, or protective clothing are needed. There need be no interruption of other operations or business in the immediate vicinity. The vacuum pick-up system is so positive in action that precision machinery, food products, or other objects of value need not be removed—or even covered—although they may be adjacent to an operating Vacu-Blaster.

P All-Electric Control System Canton Stoker Corp. announces the development of a new all-electric combustion control system. This control simplifies the installation technique, and in most cases will reduce installation and operating costs. It differs from other all-electric combustion control systems in

that the variation in coal feed on the stoker itself is effected electrically, and in addition one or more stokers can be synchronized electrically at the same time.

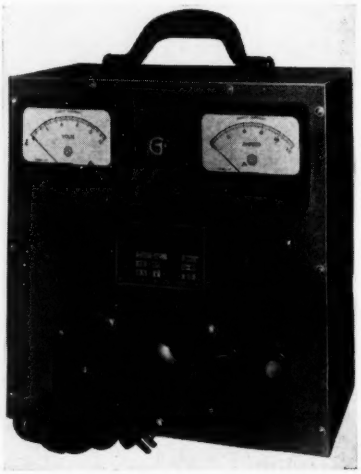
Marking the first time that an all-electric control system has been made available in a low price range for small and medium size plants, the new control will be added to the line of other synchronized combustion controls sold with these stokers.

Q Portable Bench Rectifier A new portable rectifier unit has been announced by W. Green Electric Co., Inc. It is claimed that this unit, Model No. 725S1C, is the first of its type on the market.

This rectifier, a complete d-c power supply source, with a capacity of 150 watts, incorporates all standard Company features, plus exceptionally light weight and portability, thus making it ideal for laboratory and industrial applications, as well as for battery charging.

The cabinet dimensions of the unit are 14 by 14 by 9 in., its weight—approximately 45 lb. The output is adjustable from zero to 6 v and has a continuous capacity of 25 amp.

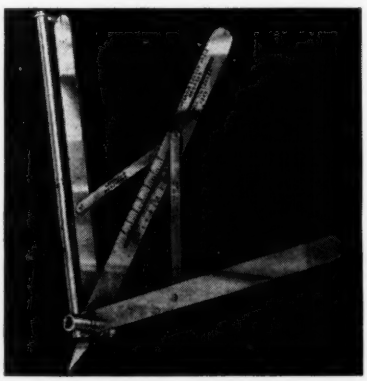
Major features are as follows: Single-phase full wave circuit, using a quadruple protected selenium rectifier element of practically unlimited life. The unit is convection cooled, has no moving parts and operates noiselessly. A heavy-duty rubber cord and plug are incorporated to match any standard a-c outlet; it has an on/off switch of the magnet circuit breaker type which provides input protection. Panel mounted fuse in the d-c circuit provides output protection. The unit has a pilot lamp with a removable jewel lamp for lamp replacement; a continuous range voltage control transformer,



from zero to maximum. A large voltmeter, with an accuracy rating of 2 per cent full scale, is connected across the output terminals and a matching ammeter indicates output current. Output terminals are color-coded to facilitate connection.

R Angle Bisector This new and improved model of the Dillon Bisector is made of stainless steel; with it, the company's announcement states, you can not only spot anchors for line poles, but you can also determine the pull on corner feet and the interior angle degrees, all in one operation.

It is said that this instrument does away with costly surveying. Any member of a crew can spot an anchor in only a few moment's time. It works on hills, curves and corners and requires no charts or figuring. To operate it is only necessary to jab the point in the pole and aim at opposite poles; the correct answer is read on the tail-piece arms. The price of the Dillon Bisector is $4.95. It is announced by W. C. Dillon & Co., Inc.



S Mercury Switch This all metal switch Type D-100 is described as introducing something new in the field of mercury switches. Ruggedly designed it provides safe operation due to a fused hermetic seal between metal and ceramic. It is announced by Mercontrol, Inc.

The switch is 4 in. long and 1¼ in. in diameter and has a continuous rating of

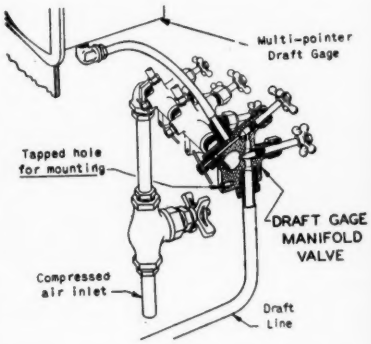
100 amp at 110 v or 220 v d-c or a-c.

The switch is entirely metal enclosed providing hazard-free operation in atmospheres where conditions of switch sparking is a danger.

Although this switch can be used in all types of remote control and automatic equipment, it is also applicable to tank rheostats of plating equipment where copper switches are exposed to corrosive fumes and burning.

At full load rating of 100 amp, the temperature rise is only 250 deg above ambient under normal operating conditions.

T Instrument Auxiliaries Production of two power plant and process instrumentation auxiliaries, manufacture of which was necessarily suspended during the war years,

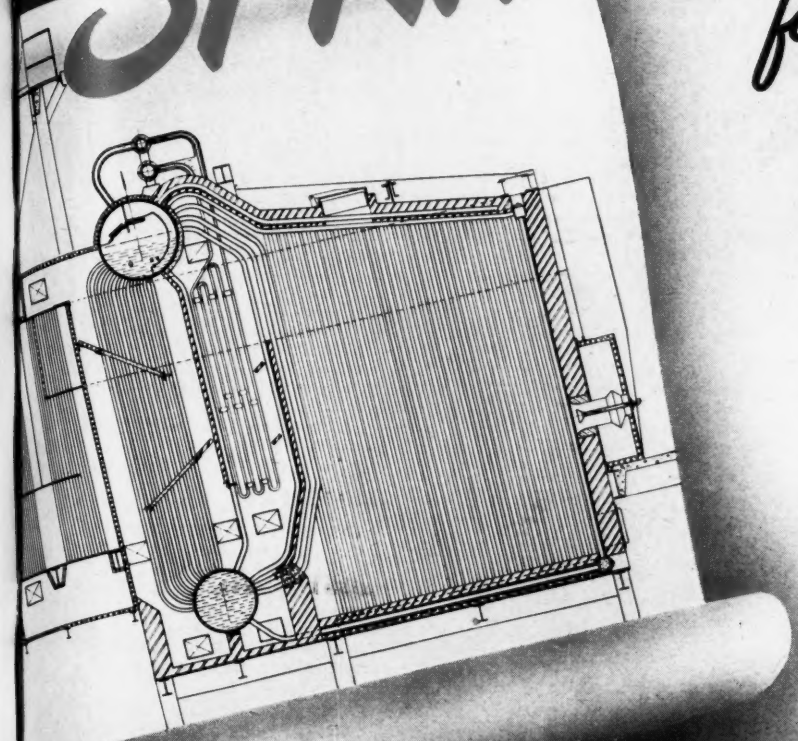


has been resumed, it is announced by The Parker Appliance Co.

The draft-gage manifold valve, illustrated, designed especially to simplify the problem of blowing out draft lines in multi-power draft gage installations, connects a compressed air supply permanently to the manifold. One of the valves in the unit shuts off the meter line, while the other permits the flow of compressed air through the draft line to remove fly-ash. The meter valve also can be set, in general service, to give any desired dampening of the pointer it serves.

The manifold units, assembled in multiples to correspond with the number of draft meter pointers, completely do away with makeshift rubber hose sections, and convenience of operation is a guarantee

Look to SPRINGFIELD for the BEST in Modern Steam Generating Units



As rapidly as manufacturing facilities permit, Springfield Boiler Co. is bringing to users of steam generating equipment all that is improved and advanced in boiler design and construction. Even in designs little changed in general appearance, these improvements are noticeable in increased reliability... efficiency of operation... ease of maintenance. In other cases, purchasers of Springfield steam generators are now getting delivery on new and specially designed units built to meet individual requirements. If you are planning for the future now, LOOK TO SPRINGFIELD FOR THE BEST!

SPRINGFIELD BOILER CO.
1951 East Capitol Ave., Springfield, Illinois

Two Drum, Bent Tube, Springfield Design

- **RADIANT HEAT FURNACE.** Water cooled surface disposed to meet each particular operating condition. Minimum furnace maintenance required.
- **DRY STEAM.** Multiple stage steam separators effectively prevent possibility of carry-over and insure dry steam at all operating rates.
- **SUPERHEATER.** Interbank type, designed to give minimum variation in steam temperature over wide range. Easily serviced, readily accessible.
- **DRUMS.** Welded, X-rayed and stress-relieved to meet all specified code requirements.
- **AIR PREHEATER.** Clean cut, easy to maintain and simple in arrangement.
- **SYMMETRICAL DESIGN.** Note that the Springfield design is compact and symmetrical. Gases enter the tube bank across the entire width of the unit. This full width flow is maintained through the tube banks, superheater, air heater and economizer, if one is used. Temperature of gases at any particular section is practically uniform across the entire width.
- **SIZES.** Offered in capacities from 20,000 lbs. up and for pressures up to 900 p. s. i.
- **FIRING.** Firing may be by coal, oil or gas.

SEE OUR CATALOG IN SWEET'S

SPRINGFIELD BOILERS

XUM

against neglect of necessary blowing out of the lines.

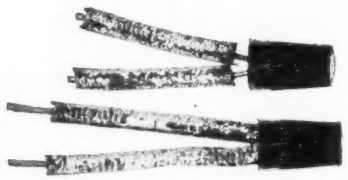
A zero-check plug is incorporated in the manifold to facilitate testing of instruments, as well.

The unit is reversible, permitting mounting under conditions when the draft line is desired to run either upward or downward from the instrument panel.

Also in production is the pressure snubber, a device of improved design to eliminate gage line fluctuations which produce excessive gage wear and inaccurate readings.

U Wire Connector This new universal "4-in-1" size, announced by Holub Industries, Inc., is a solderless and tapeless Wire Connector which eliminates the need of using four sizes. It is approved by Underwriters' Laboratories for joining 46 different wire combinations ranging from 2 No. 18 to 4 No. 14 with 1 No. 18 or 2 No. 12 with 1 No. 16, solid or stranded wires.

The simplification of one connector for all common wiring joints avoids confu-



sion, increases efficiency and keeps down inventory on the part of electrical contractors, plant electricians and electrical manufacturers who make joints in production. It is designed for making fixture joints, roughing-in joints, sign wiring and joints in electrical equipment and machinery.

It is described as easy to use—just skin wires and screw on—that's all! It is a one piece device, made of bakelite and has a coiled spring insert which assures a perfect electrical and mechanical joint.

V Low Cost Temperature Controller Ready for control of ovens, stills, baths, presses and coolants, Leeds & Northrup's new Electromax fills the long-felt need for an inexpensive temperature controller which has high sensitivity and versatility and needs practically no attention.

Especially designed for those applications where indicating and recording are not required, Electromax signals and controls only, although temperature readings can be taken manually with it at any time.

The instrument consists of a Wheatstone bridge circuit with a vacuum-tube amplifier as the detector. Vacuum tubes are standard, easily-purchased types, require no matching, balancing or other special selection. It's completely a-c operated—needs no dry batteries or standard cells. The lack of indicating or recording mechanism makes it a practical "zero maintenance" instrument.

Temperature-sensitive elements used with Electromax are Thermohms, resistance thermometer bulbs. As with other of this company's instruments, the length of leadwires does not affect calibration, and the location of Thermohms can be changed whenever desired.

The instrument case is only 11 9/16 in. by 11 1/16 in. by 9 1/16 in. and can be mounted wherever convenient. Standard ranges are 0 to 250 F and 0 to 1000 F or the corresponding ranges from 0 to 150 C and 0 to 550 C.

W New A-C Welder The Lincoln Electric Co. announces the new "Fleet-Arc" a-c welder. This new welder is equipped with the "Arc Booster" which is said to augment the current the instant the arc is struck. The arc is started automatically the moment the electrode touches the work. This added feature of the new welder has been accomplished safely without the use of special high frequency devices or higher voltage.

A selector switch on the front of the welder governs the amount of booster current to be used in striking the arc. This provides a complete range of striking intensity to suit requirements in the welding of thin sheets or heavy plates, making of

tack welds, or in the use of various types and sizes of electrodes.

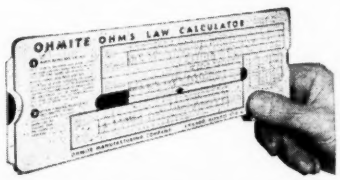
Current control, continuous and self-adjusting, is provided by the rotating reactor control, which affords fast setting throughout the exceptionally wide range of the welder. The operation of current control is fast and involves the simple act of turning a hand wheel which requires a minimum number of turns to cover the range. The amperage is indicated on a calibrated dial on the face of the welder, placed in a weatherproof and readily visible position on the face of the unit.

The reactor current control, held in position by cone brakes and actuated by a self-cleaning chain drive, is smooth running and durable.

Arc characteristics of the new welder are excellent, with a new type reactor control designed for high responsiveness to changing arc conditions.

X Ohm's Law Calculator A new pocket-size Ohm's Calculator incorporating a number of new features has just been announced by Ohmite Manufacturing Co.

The new calculator, like the previous Ohmite calculator of which close to one-half million copies have been distributed to engineers, students, and teachers, provides a simple and handy means of solving resistance calculations. With one setting of the slide it gives the answer to any Ohm's Law problem—reading directly in ohms, volts, amperes, and watts. It will



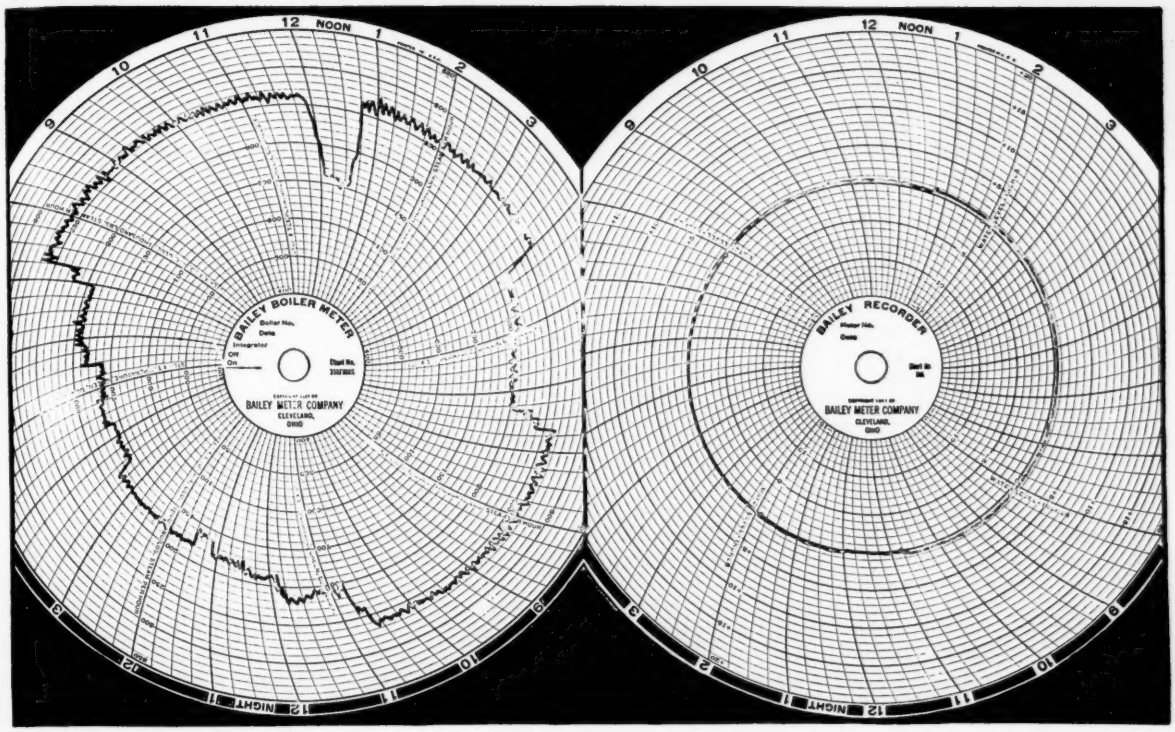
also solve parallel resistance and series capacitance problems, and will multiply, divide, and find squares and square roots. The range covers all currents, resistances, voltages, and wattages commonly encountered in industrial and radio work.

All computing scales of the new calculator are printed on one side. On the opposite side are given the Composition Resistor Color Code and the catalog number of stock resistors and rheostats of various resistance values. The new calculator is made to handy pocket size (9 in. x 3in.) of heavily varnished cardboard, and is priced at 25 cents.

Y Multiple Contact Connector A new multiple contact connector, just developed by the Winchester Co., is particularly adapted to limited space applications where reliable plug-in operation is required. The rectangular monoblock connector can also be supplied with a self-contained locking device which eliminates the necessity of any external clamping arrangement.

Molded of Melamine plastic, the one-piece inserts reduce the danger of flash-over due to moisture and dust accumulations. Not only does this monoblock type construction permit easy removal of contacts, but it also makes the connector more rugged. Two heavy guide pins, acting as ground contacts, perform the additional functions of alignment and polarization.

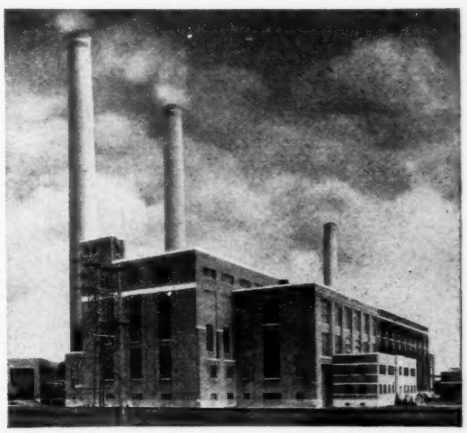
The multiple telescoping barriers which serve to isolate contacts increase both surface creepage and air gap between adjacent contacts. Thus the connector may be used at extremely high potentials. Minimum air gap of 1/4 in. is maintained between all contacts.



COPES AT WESTOVER STATION

OF NEW YORK STATE ELECTRIC AND GAS CORPORATION

Boiler loads at Westover Station at times fluctuate more than you might expect in an 875-psi, 885-F utility installation. Yet COPES Flowmatic closely stabilizes boiler water level, as shown by the charts, on the two Foster Wheeler three-drum, bent-tube steam generators. Except for shrink and swell, the level is held within one inch by two-element COPES Control. The story is told in Bulletin 463—Boiler Feed Control at Westover, Greenidge and Jennison Stations. Write—your letterhead, please—for this 16-page report.



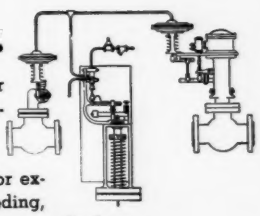
NORTHERN EQUIPMENT COMPANY
272 GROVE DRIVE, ERIE, PENNSYLVANIA
Feed Water Regulators, Pump Governors, Differential Valves, Liquid Level Controls, Reducing Valves and Desuperheaters
BRANCH PLANTS: Canada, England, France • *Representatives Everywhere*

★ GET CLOSER LEVEL CONTROL WITH COPES FLOWMATIC

DESUPERHEATER...

Here's a desuperheater every bit as effective on light loads as at full capacity. No water dribbles into the steam line. There is complete atomization of the cooling water from zero to full load because the opening of the spray nozzle—not the pressure drop across it—is varied with steam temperature. A self-contained unit, as *dependable* as the COPES Feed Water Regulator. Write for Bulletin 405-A.

MASTER CONTROL...



Remote control of reduced water or steam pressures, with single or multiple pressure reducing stations, is *dependably* accurate with the COPES Master Control. Adapted for excess pressure control in boiler feeding, where one or more turbine-driven pumps discharge into a common water header. Details on request.

Double Check ON BOILER WATER LEVELS

Here's an instrument that brings boiler water level indication right down to eye level, on the instrument panel or other convenient location—a perfect *check* on hard-to-see overhead gages.

Yarway's Remote Liquid Level Indicator is always accurate because it is operated by the boiler water itself—by the pressure differential between a constant head of water and the varying head in the boiler drum. Action is instant, constant, frictionless. *There are no stuffing boxes.* Indicating mechanism is never under pressure. Mechanism is perfectly balanced on jewelled bearings outside of the pressure chamber.

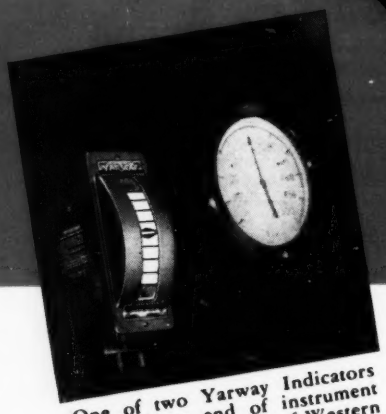
From coast to coast, the Yarway Indicator is meeting with enthusiastic approval. One prominent user said, "If I couldn't get another one like it, I wouldn't sell the one I have for many times its cost!"

More than 2500 have already been bought for indicating boiler water level, feed heater water level, and superheater pressure differential. For complete description of operating details, write for Bulletin WG-1821.

YARNALL-WARING COMPANY

114 Mermaid Avenue Philadelphia 18, Pa.

Typical instrument panel mounting of Yarway Indicator in rubber manufacturing plant.



One of two Yarway Indicators mounted on end of instrument panel in boiler room of Western utility.

YARWAY REMOTE LIQUID LEVEL INDICATOR

WHAT LEADERS SAY

The Outlook For Freedom

By PAUL G. HOFFMAN

UNLIKE some people I believe we should do some worrying about our free economy and our free society provided it is directed toward definite objectives.

To worry successfully about a problem requires an engineering approach. Engineers know that unless they get the facts, the facts will get them. They know that neither emotional outbursts nor name-calling is resultful. Furthermore, they are willing to *face* the facts and translate them into a rational plan of action. In short, engineers make much sense.

The first worry I want to share with you is that of labor-management relations. Our failure successfully to worry about that problem already has cost us billions of dollars. It has also put in jeopardy our entire reconversion program.

According to the Bureau of Labor Statistics 98,225,000 man days were lost because of strikes during the first 9 months of 1946. That is an all-time high, according to the BLS, and compares with an average of 13,630,000 man days lost in corresponding periods during the years 1935 to 1939. These figures would indicate a loss to workers of at least $750,000,000 in wages. I am sure you will agree that these figures are appalling, but they tell only part of the story. They cover only the direct wage loss as a result of strikes. They do not include collateral losses of wages and profits in trade and service industries, nor do they include the production and wages lost in industries forced to shut down because of strikes outside their own plants.

Studebaker, unlike most of its competitors, was able to reconvert to peacetime operations without a strike in its own plants. Nevertheless, the indirect cost of strikes to us has been tremendous. From October 1, 1945, to June 30, 1946, Studebaker was scheduled to produce 134,000 passenger cars and trucks. But what happened? Through no fault of ours, we produced only some 43,000 units during this nine-month period, and our failure to attain scheduled production was due almost entirely to strikes and slowdowns in plants of our suppliers. This failure cost our employees approximately 15,000,000 manhours of work, or more than $20,000,000 in wages, and deprived our transportation system of some 90,000 badly needed automotive vehicles.

From figures such as these it is apparent that labor and management must bury the hatchet if our economy is to survive. In my opinion, two major moves are necessary. First, we must have a new set of ground rules controlling collective bargaining. In this connection, an intensive study of the entire problem is beng made by a special committee of the Committee for Economic Development. To show you what I mean by a new set of ground rules, let me tell you about one of the many suggestions that has been made before our special committee. It has been suggested that the rules governing collective bargaining should by their very nature put pressure on both management and labor to rely upon persuasion rather than coercion for the attainment of their objectives. For example, management should be prevented from entering into collective bargaining negotiations with the authority from the owners of the business to stage a lockout if its terms are not met. Similarly, labor leaders should not be permitted to enter negotiations with a blind strike vote in their pockets. True bargaining cannot be carried on when either party is pointing a loaded and cocked gun at the other.

The second major move required is a change in attitude on the part of both management and labor. Today, emotion plays too great a part in collective bargaining negotiations. Both parties too often enter negotiations with a chip-on-the-shoulder attitude. They are both ready to fight at the drop of a hat. Rather than hanker to fight each other, both employers and labor leaders should be determined to fight for peace—to fight for quick settlement of differences.

Unless management and labor demonstrate quickly a desire and an ability to bargain collectively, they face the rick of legislation based on emotions rather than reason. The public already is in a dangerous mood as a result of our strike experience since V-J Day. If this mood should express itself in the form of punitive legislation directed against labor unions, the results would be as unfortunate for management as for workers. We want new ground rules, yes, but ground rules that will promote peace rather than bitterness and conflict.

The second worry I want to share with you concerns inflation. Recently I returned from Europe. There I saw the havoc which inflation causes. I hope this nation will never be called upon to grope its way out of the ruins resulting from the uncontrollable fury of inflation. What I saw made me more determined than ever to work for measures which will choke the inflation threat before it has a chance to get started.

How can we combat this menace? There are many things we can do, most important of which, in my opinion, are the following:

1) We must increase productivity. High productivity cuts unit costs and

(*Continued on Page 86*)

Paul G. Hoffman is not only president of The Studebaker Corp. of South Bend, Ind., but has also attained national prominence as chairman of the Committee for Economic Development. The work of that committee, in our opinion, has been one of the principal factors in keeping our economy going as well as it has gone during the present difficult reconversion period. By its work in inducing individual businesses and particularly small businesses to make specific plans and get right down to cases in making them effective, it has been largely responsible, many people believe, for the non-appearance of predicted widespread unemployment during this reconversion period. Thus, when Mr. Hoffman speaks of the current problems of business and makes specific suggestions for solving them, as he does here, he is speaking from a background of the most intimate knowledge of American industry, from first-hand knowledge that we can get things done if we determine to do them.

Mr. Hoffman was born in Chicago in 1891, and attended the University of Chicago. He started in business as porter for the Chicago distributor of the Halladay car. In 1911 he became salesman for Studebaker in Los Angeles, and by 1917 had become branch manager of that district. After serving as 1st Lieutenant in the field artillery, U. S. Army from 1917 to 1919, he purchased the Studebaker Los Angeles retail branch in 1919. He was made vice-president of Studebaker Corp. in 1925 and president in 1935.

Mr. Hoffman has been awarded many honorary degrees by Rose Polytechnic Institute, University of Southern California, Dartmouth, Grinnell and Kenyon colleges and others. He is a director in many business and educational enterprises, such as New York Life Insurance Co., Encyclopedia Brittanica and the like. He is honorary chairman of China Relief, Inc., director and vice-president Automobile Manufacturers Association; member Business Advisory Council, Department of Commerce; Trustee Kenyon College, University of Chicago, Tax Foundation.

The comments above are extracted from a paper delivered on December 3, 1946 before the Management Luncheon, 67th annual meeting, ASME, New York City.

Starting Up Steam Generators

By **JOHN C. GORE**, Power Engineer, General Foods Corp., Post Cereal Division

THE NEW POWER plant, after many feverish days of preparation, is now ready for service. Today is the starting-up date and the plant will be placed in active service for the first time. This date had been established weeks before but to the men building the plant it had seemed to be only a bit of wishful thinking on the part of those who had selected the date.

Thousands of people unknowingly have been waiting for this day but strangely these people do not realize the importance of today in their lives. A new servant which may add many pleasant hours to their lives is being born, but this important fact has never attracted their attention . . . a new public servant to lighten drudgery, to provide warmth, to help in healing the sick and to aid the crippled is now ready for service. After today the new plant will bring laughter, music, color and gaiety into many homes in the surrounding area. The faces of loved ones in these homes will be visible by the light which has its source in the new plant and by the aid of the same light many will see to increase their knowledge and arrive at a better understanding of this world through the printed thoughts of others. Many useful and beautiful articles will be fashioned for these people's satisfaction and needs by the manufacturing processes which will use the new source of available power. Indeed it is impossible to list or to comprehend the ultimate effect that this new plant will have on people's lives in the vicinity but it is safe to say that probably not a single person in the whole area will escape from the influence which it will have on people's lives.

To the men gathered in the new power plant this day is very important but it is doubtful if they are thinking of its importance to others outside of the small group of which they are a part. Some are thinking that this day marks the end of a long period of building and hard work. The engineers who designed the plant see in this day a dream which has come true. The management regards this day as a starting point in a period in which additional income will be available from a new source. To each and every man in the plant this day has some meaning and to the majority it is very important.

To the operators the starting-up day probably means as much, if not more, than it does to any of the other groups involved. This is their day. Today is the starting-up day when the operators take over the responsibility for the new equipment. They will live with this equipment and even the noise of it will seem to become a part of their very lives. At times they will curse it under their breath and then in turn they will sing its praises with a great amount of pride when things are going right. As these men gather quietly in front of the new unit for last minute instructions an air of tense expectancy pervades the entire plant. The service engineer is busy asking questions of the group and as each man assures him that the assigned tasks are completed he nods his head in quick approval and continues his questions until assured that everything is in readiness for starting up.

Check and Double-Check

The boiler unit has been thoroughly cleaned. All access, inspection and ash pit doors have been closed. All dampers including the burner windbox dampers have been closed and the automatic control cylinders have been connected up and are ready to be operated on manual from the boiler panel board. The drum manholes have been closed and the boiler is full of condensate or treated softened feedwater. The unit has been filled using the emergency or auxiliary feedwater piping in order to ascertain that each operator know the location of the valves and how to use this emergency line if necessary. The feedwater pumps and feedwater control valves have been checked and tested and are ready for immediate service if water is required for the unit. The valves on the superheater drains, drum vents, economizer recirculating lines and the valves in the piping between the drum and the water columns are wide open. The drain valves on the main steam header are also wide open to drain off any water which might slip through a defective non-return and gate valve. Water column blowdown or drain valves, the non-return and main steam header valves are closed as are the blowdown valves on all drums and headers.

The pulverizers have been checked, adjusted and calibrated for operation. Many of the operators know from aching muscles and memories of several days hard labor spent in adjusting these machines that they are rugged, heavy pieces of equipment well adapted for the work of grinding coal. The coal feeder controllers have been adjusted for remote manual control from the main panel board and coal for these feeders is available from the full bunkers overhead. The oil burners are clean and the oil pump is now recirculating oil through the heater bringing it up to the required temperature for proper atomization and the steam supply header to the oil burner is open. This steam supply header is hot and free of condensate as indicated by the free blowing drain valve which is opened for a short time. All instruments, thermocouples and other testing apparatus are in place waiting for actual use. Ref-

ABOUT THE AUTHOR

John C. Gore was born in Beaver Falls, Pa., in 1908 and got his education the hard way . . . he worked at the Beaver Falls plant of Armstrong Cork Company for six years and during these six years attended night school in Pittsburgh. He had to drive 80 miles to get to Carnegie Tech. and back again and "had a lot of fun doing it." Having time on his hands, Mr. Gore managed to secure three student Activities Keys and joined Phi Nu fraternity.

He received his B S. in Mechanical Engineering in 1941. At the time, Mr. Gore was working in the Pittsburgh plant of Armstrong Cork Company and had held the position of Power Engineer for three years before receiving his degree; in this position he had had supervision of the power plant, pipe shop and electrical shop.

Upon leaving Armstrong Cork Mr. Gore became a service engineer for Babcock & Wilcox and it was here that he gathered a considerable portion of his broad experience. He traveled a great deal, visiting small and large plants, starting up new equipment and answering trouble calls. His work area consisted of New York, Connecticut, Ohio, West Virginia, Indiana and Pennsylvania.

But let Mr. Gore tell the rest of it himself: "I have been with General Foods Corporation for the past two years. At the present time we are installing new coal handling equipment and a new pulverized coal-fired boiler and all this takes up a great deal of my time. The Power Department, which is my responsibility, consists of the power plant and a Results Engineering Department. (*Power Plant Engineering*, May, 1945). We keep all records of power services, namely: steam, electric, gas, water and compressed air. The efficient use of these services is also our responsibility and this leads us into dryng and heat transfer problems for the factory production operations." We'll hear more from Mr. Gore, later.

* See "Preparing a Steam Generator for Service," page 99, November, 1946, POWER PLANT ENGINEERING.

Mr. Gore, in this article,* not only describes the tense moments felt by every man in the plant when starting-up day arrives, but also he makes the reader feel the immense social and economic significance behind the drama of putting this new plant on the line. From the moment the men gather in front of the boiler for last minute instructions until, late that night, when the service engineer curls up on a pile of insulation boxes for a few hours sleep, the author shows the how and why of every action and precaution taken to assure a long and profitable life for the new-born power plant. Mr. Gore writes his articles from actual experience

erence marks have been established for checking casing and lower header expansion and movement which will occur as the boiler unit is brought up to operating temperature.

The "Go-Ahead" is Given

Finally satisfied that all is in readiness the service engineer tells the man selected as the operator, to go ahead. The induced and forced draft fans are started in the order named. The uptake damper is slowly opened until 0.4 to 0.6 in. of suction is indicated on the furnace draft gage. The operator signals to his helper to slowly open the windbox dampers about half way open. The care and caution shown in the actions of both men in making this simple adjustment indicates how unaccustomed they are to their new duties. The operator then opens the forced draft or secondary air damper slowly and air pours into the huge furnace with a soft rushing noise. The operator watching every movement of the draft gages notices that the sudden inrush of air into the furnace is causing the furnace draft pointer to move upward toward a positive pressure. He operates the induced draft controller to open the uptake damper so that the furnace draft is held on the suction side showing reading varying between —0.2 and —0.6 in. of water. Slowly balancing the controls manually the air flow is increased until a rate of 25 per cent of the maximum air flow for the unit is reached. This air flow is indicated by the position of the air flow pen on the steam-air flow meter and this reading can be quickly checked by calculations using the square root law for varying air flows and the expected performance figures which give the design draft losses. During this period of adjustment the electrical crews and the meter men are checking the fan and the pulverizer interlocks securing the necessary data to make preliminary settings of the purge flow interlock system.

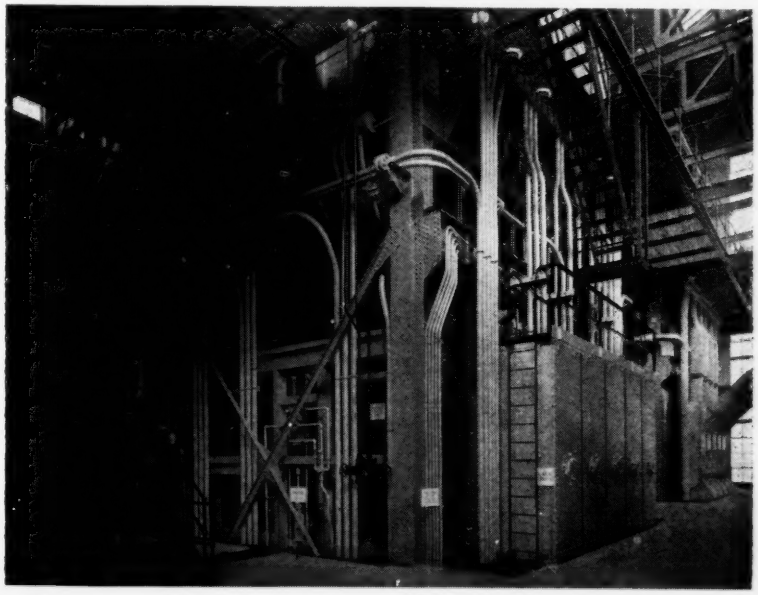
The air flow is held at 25 per cent of the maximum air flow for a full five minutes and the boiler, economizer air heater, dust collector and all ducts are swept free by the inrushing air of any stagnant or combustible gas bodies which may have collected in any of these locations. The service engineer has cautioned the operators telling them never to omit this purging process before lighting off the initial burner in a furnace in which no flame is present. He has also told them never to shorten the purging period to less than five minutes as he knows from experience that if the purge flow interlocks are omitted from a unit that the natural tendency is to shorten this period to three minutes or even less. This tendency to shorten the purge period is especially attractive to operators after an accidental loss of ignition when their whole attention is centered on the restoration of normal load carrying capacity which seems to be of primary importance at that time. Safety precautions which would prevent a possible furnace explosion are ignored or given very little consideration during the excitement of restoring normal conditions and as a result many furnace explosions occur during such a period.

The Value of Interlocks

The purge flow interlocks will prevent the operator from ignoring the proper purging procedure. These electrical interlocks will prevent any fuel firing equipment from being operated until the proper purging operation is completed. In this way a mechanical safe guard is added to assure correcting operating procedure, and the possibilities of a dangerous explosion due to the ignition of combustible gas bodies in the equipment is greatly reduced. Normally it requires from three to five minutes for the operator to ascertain that all auxiliary equipment is available for operation after an accidental outage. If the purge period is started immediately after the loss of ignition occurs it will be complete by the time the operator is again ready to light off the burners. Thus shortening the purge period does not result in any time savings but simply indicates that correct operating procedures are not being followed.

With the completion of the purge period the operator under the watchful eye of the service engineer and the assorted group of spectators gathered for this historic occasion prepares to light off the burners. The air flow is reduced by partly closing the forced draft damper followed by the closing of the induced draft damper so that furnace draft readings are maintained in the normal range. The burner windbox dampers are all closed and the damper of the burner which is to be used is reopened a slight amount. The induced draft damper is given a final adjustment so that a slight amount of furnace draft is available (—0.2 to —0.3 in.). The windbox draft gage is then checked to make sure that a slight positive pressure exists on the windbox. The air flow through the burner is now very low and a hand lighter torch can be inserted through the burner ports to the front of the burner without the flame blowing off the torch and going out.

The operator selects a hand kerosene torch and the spectators watch as one of the company officials carefully lights this torch with a very expensive cigar lighter. This ceremony is evidently required by the importance of the occasion but the operator wonders if his substitute helper realizes how much soot and dirt is collecting on the white shirt he is wearing. White shirt or no white



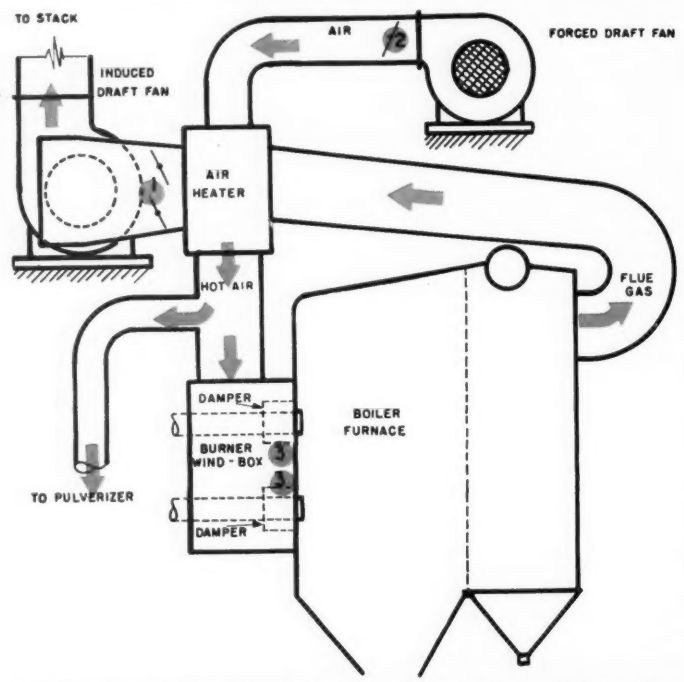


Fig. 1. This drawing shows the proper sequence of operation for establishing air flow before lighting off. (a) Close all dampers. (b) Start induced draft fan. (c) Open induced draft fan damper (1), pulling suction on furnace (0.5 to 0.6 in. furnace draft). (d) Start forced draft fan. (e) Open forced draft damper (2), to give positive windbox pressure. (f) Open burner windbox dampers (3), to let air into furnace. (g) Open induced draft damper and then forced draft damper to give air flow desired. Do this slowly, always maintaining suction on furnace. If you blow air into furnace you must increase the pull-out or suction, using induced draft fan, in order to maintain furnace draft desired

shirt the temporary helper stands back with a big grin covering his face as the operator swings the smoky flaming torch into the burner box. As the flame disappears into the unit which it will bring to life the grinning helper is forgotten even though it has been largely due to his efforts that the new boiler unit is ready for service today. The operator is now thinking only of the instructions which have been given to him during the past week.

Lighting-off

The flaming torch is carefully inserted through the burner windbox and held directly in front of the oil lighter or burner tip. The oil valve is quickly opened wide and a flame instantly flares at the end of the oil lighter. The service engineer who has been watching every move of the operator quickly adjusts the uptake damper to maintain —0.2 in. of furnace draft while the operator checks and adjusts his oil pressure and atomizing steam pressure to the burner to determine if they are within the desired range for correct atomization of the oil. The burner windbox damper is slowly opened to admit air to the burner until a clean yellow oil flame without smoky ends or long brilliant sparkling tails is secured.

The service engineer almost unnoticed is checking the coal feeders and opening the coal burner line from the pulverizer which supplies the burner in which the oil torch is burning. He signals the operator to go ahead but the operator remembers his instructions and takes time to increase the furnace draft to 0.4 or 0.5 in. of water by opening the uptake or induced draft damper. He also makes adjustments to the burner damper opening it about ⅓ of the total opening so air will be available to burn the coal when the coal burner is lit off. The forced draft damper is opened to provide a positive windbox pressure and a final adjustment is made to secure the correct furnace draft. The service engineer stands back watching and as the operator checks to make sure that the correct burner line is open he is pleased. It is difficult to keep pulverizer burner lines separated in one's mind on a new job and if the pulverizers are not visible a mistake is very easily made. To bring coal into a burner that does not contain a light-off torch would result in delayed ignition and if this delay is long enough for the furnace to fill with powdered coal a very serious explosion will result. Yes, this man promises to make a good operator as he takes nothing for granted but checks every detail.

Starting the Pulverizer

The operator goes back to his station at the control panel board and carefully selects the proper electrical switch for starting the pulverizer. Sleepy Joe in the basement at the time has been cleaning up around the pulverizers. The low rumble of the starting mill and the low soft whine of the fan causes Sleepy Joe's eyes to widen. The cloud of dust that suddenly blows from the air cooled motor startles Joe and he leaves that particular spot without any sleep walking or loitering. With the mill running and up to speed, the operator starts the coal feeder and feeds coal to the pulverizer for a full minute until the metallic noise of the mill changes to a low rumble. He glances at the service engineer who quickly indicates that the mill has enough coal in it and then he slowly opens the primary air damper to admit air to the pulverizer. The air rushing through the pulverizer picks up the fine powdered coal and carries it to the burner. The expectant watchers note the flame reflection on the glass burner ports and darken and then brighten and increase in intensity. The operator realizes that the coal burner is now lit and since this is his first experience with pulverized coal he is somewhat surprised at the ease and apparent simplicity of the whole operation.

The operator remembering instructions turns to watch his draft and differential gages. The furnace draft is rough and is now approaching a positive pressure and he opens the uptake damper to give a —0.2 in. furnace draft. This seems to brighten up the flame and he slowly increases the primary air flow to the valve which the service engineer has specified as being desired and which can be read on pulverizer differential gages noting that this gives a darker flame he adjusts his furnace draft and then opens the forced draft damper to admit more air to the burners. He quickly adjusts his dampers increasing air flow until the flame is brilliant and a large amount of pulsation of furnace draft is reduced as ignition becomes more stable. The service engineer is making initial adjustments on the pulverizer coal feeder meantime feeding coal by hand depending on the sound of the pulverizer as a guide to proper coal loading for the mill. He places the feeder controller in operation and after several minor adjustments, arrives at a setting which satisfies him that the coal-air mixture is rich enough to maintain burner ignition without the pulverizer flooding with coal and stalling. Final adjustments of this controller will be made after all differential gages have been checked for calibration and when the pulverizer is in continuous service with the boiler unit under load.

The operator, now satisfied that the burner is lit and burning in a stable manner, asks the service engineer to watch the control board while he observes the flame through an observation port at the side of the furnace. Somehow he manages to get ahead of two or three spectators who are crowded around this observation door giving each other knowing and pleased looks. He determines the condition of the flame and

then goes back to the control board and makes some additional adjustments which brighten up the flame. The service engineer now relieved from his temporary duties at the control board joins the observers for a look at the burner flame. He then returns to the control board and adjusts the coal feeder to give more coal and opens the burner damper a slight amount to admit additional air. The operator adjusts the furnace draft to accommodate these changes and checks the water level. He also glances over the temperature charts and notes that no readings are showing. Suddenly a shout is heard from the man who has been reading thermocouples at the potentiometer station on the platform overhead and he looks up to see the man waving his arms indicating that temperatures are getting too high.

The man above has been instructed to signal when gas temperatures into the superheater section approach 1000 F and the service engineer knows that to apply any more heat at this time would not be advisable. The pulverizer has too high a firing rate at minimum load conditions and to continue firing coal would undoubtedly cause damage to the superheater elements which are of alloy designed for a temperature of 900 F while other parts of the unit might be damaged by unequal expansion stresses which occur when parts are too quickly heated up. The service engineer glances at the clock noting that the coal burner has been lit about 7 minutes and he instructs the operator to shut the pulverizer down.

Stopping the Pulverizer

The operator shuts off the coal feeder and slowly increases air flow to the mill to sweep all powdered coal from this equipment. The flame at the burner continues for several minutes but as the mill is cleaned out the coal flame slowly dies out in the burner. The oil torch is left burning and after all traces of the coal flame have disappeared the pulverizer is shut down and the primary air damper is closed. The operator has started to close the valve in the coal burner line but the service engineer tells him to leave it open as the same mill will be used again in a few minutes. This burner line valve or gate however must be closed if the burner is to remain out of service for any length of time or if another burner is to be used for firing. The furnace draft is lowered to 0.1 to 0.2 in. of water by closing the induced draft fan damper and the unit is allowed to stand idle with only a small oil lighter flame burning in the furnace for the next 10 to 12 minutes. This time is allowed for the boiler to soak up and to equalize the heat distribution through the various ports.

The service engineer has disappeared and it is several minutes before he returns hot and dirty from crawling up into the space around the bottom headers to secure his first check measurements on expansion of the unit. He tells the operator that the time allowed for the unit to soak up heat is now over and that coal should be fired again for a period of from 5 to 7 minutes. The operator increases his furnace draft and starts the pulverizer and, following the procedure outlined above, soon has the coal burner again in service. This procedure of intermittent firing is continued until pressure starts to build up in the drum. The operator becomes more confident and sure of himself with each firing period and the service engineer noting that operation is going smoothly takes the opportunity to again check expansion readings and to inspect the unit for buckled casing plates or other signs of faulty expansion joints. He also visits the potentiometer station and talks with the man reading thermocouples and checks the readings available to make sure that all superheater metal temperatures are being maintained below 900 F by the firing schedule being followed.

As the service engineer returns to the control board the operator is adjusting the burner dampers in preparation for lighting off. The man's assurance is remarkable and the pulverized coal burner is ignited in a smooth easy manner with very little furnace disturbances. Hours of instruction and training during the past few weeks have prepared this man for his new duties and it is now only a question of time until he secures the complete confidence which is necessary to make him a first class operator capable of handling the equipment in any emergency. During the coming weeks the service engineer will have some additional work in instructing the new operator but his main duty from now on will consist of watching for any careless acts which are likely to develop if the new operator becomes overconfident.

The drum vent is closed when the drum steam pressure gage shows 25 psi. The superheater drains are left wide open to assist in removing the water which fills the lower U bends in a pendant type of superheater. This water must be boiled out of each element before steam will circulate through the element to properly cool the upper parts of the metal tube. If this steam circulation has not been established the firing rate must be restricted to avoid overheating the superheater elements. The thermocouple tube metal temperatures must be watched and firing rates must be restricted in this case so that these temperatures do not exceed 900 F. When steam circulation is established through an element the thermocouple temperature reading will clearly indicate the all clear condition as the metal temperature will drop to a constant value only a few degrees above saturated steam temperatures. The thermocouples should be installed near the top of the superheater

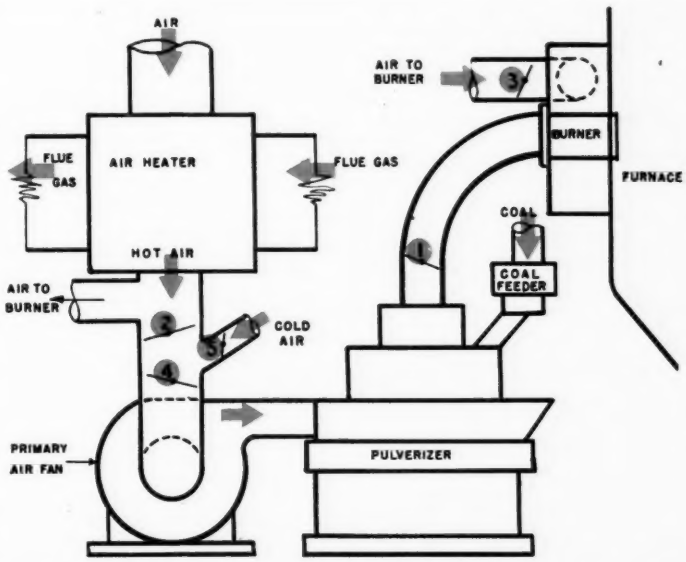


Fig. 2. Diagram showing steps to follow in starting up pulverizer. (a) Close all dampers. (b) Open coal bunker gate to feeder. (c) Open coal-air valve (1) in burner line. (d) Open hot air damper (2). (e) Open burner damper (3) about ⅓ open. (f) Light oil torch in burner. (g) Start pulverizer and primary air fan. (h) Start coal feeder and run 2 or 3 minutes. (i) Open primary air damper (4) slowly. (j) Burner should light-off in 5 seconds. If it doesn't light-off stop the primary air fan and pulverizer and close primary air damper. Investigate for trouble. Clear and repeat above routine. When burner is lighted: (k) Adjust coal feeder for automatic operation. (l) Open cold air damper (5) and adjust dampers (2) and (5) so coal-air mixture leaving pulverizer does not exceed 160 F temperature. When shutting down the pulverizer follow this procedure: (a) Open cold air damper (5) and shut hot air damper (2). (b) Shut off coal feeder. (c) As burner dies out open primary air damper (4) and clean powdered coal out of pulverizer. When flame goes out: (d) Shut primary air damper (4). (e) Stop primary air fan and pulverizer. (f) Close all dampers

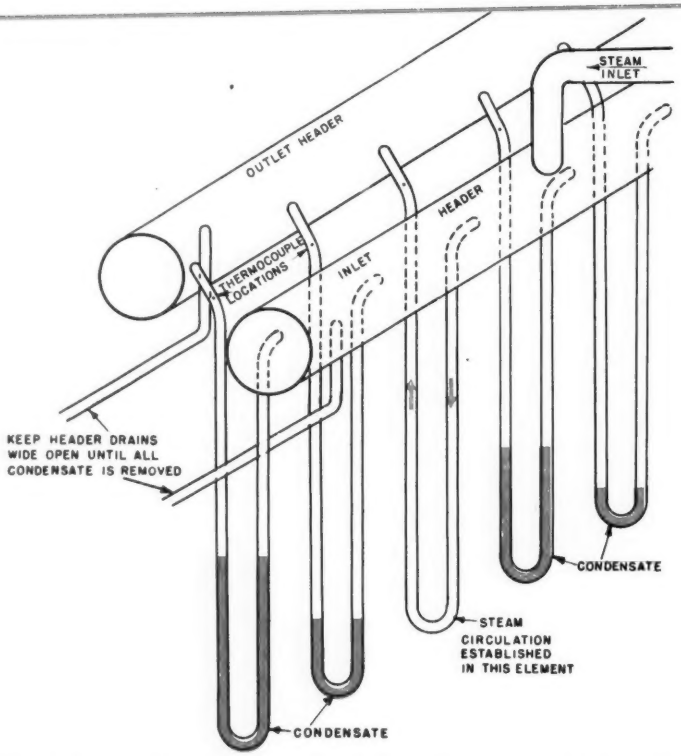


Fig. 3. Shown here are possible superheater conditions when starting up; this is a pendant-type superheater, non-drainable. All condensate must be evaporated and circulation must be established through each element before boiler goes on line. High firing rates will overheat tubes thus causing failure or warping if element is not free of condensate

element on the steam outlet leg so that a clear indication is secured when steam circulation through the tube is actually established.

Establishing Circulation

With the above limitations in mind the service engineer varies the firing schedule still holding to the restriction that the pressure rise each hour shall not exceed that equivalent to 100 F rise in saturated steam temperature as he has previously instructed the operator. The firing rate for the pulverizer is increased but the actual firing periods are shortened. The service engineer's experience has indicated that the rapid and quick application of heat will cause the water to boil out of the U bends of the superheater tubes in a shorter time than if the firing rate is held low and maintained for longer periods. It is important that steam circulation shall be established through each tube or element before the boiler unit is placed under load. A sudden increase in firing rates under load conditions will cause the superheater tubes to overheat and bulge or fail near the top of the element if steam circulation has not been established to cool the metal down to the allowable temperature of the alloy used in manufacturing the tube.

Finally after some hours of intermittent firing, operating steam pressure is approached and all of the superheater tube temperature readings indicate that steam circulation has been established. The superheater drains are still open wide to aid in the elimination of condensate from the superheater headers and to assure that sufficient steam circulation is maintained through the tubes. The length of the firing periods have been increased due to the higher steam pressures. The water loss through these drains has been considerable. The original drum swell and the high water level due to the heating-up of the water in the boiler has all disappeared and water has been added on several occasions to make up for the loss through these drains. The main line to the turbine has been warming up for a number of hours. All the drains in this line have been opened to eliminate condensate and to aid in establishing steam flow through the piping. The use of steam to warm up the main turbine steam line helps to maintain flow through the superheater and as the pressure increases the turbine operator starts up the turbine-driven oil pump to provide oil for the turbine bearings.

With steam at the turbine throttle the turbine operator knows that the moment he has been waiting for is rapidly approaching. As the steam pressure slowly increases he makes all the initial preparations for starting up the unit. The drains are opened and steam is bled into the huge casing to warm up the rotor which is turning slowly, driven by the small turning gear motor. As operating pressure is approached the turbine operator slowly opens the throttle valve and the machine speeds up and rotates free of the turning gear. The turbine operator leaves the throttle valve to check bearing lubrication and to make sure that the machine is free of water before closing the drains. When he is satisfied that operation is normal he finally goes back to the throttle valve and opens it another slight amount again increasing the speed of the machine.

The turbine operator tries to remember all of the duties involved in this initial starting up period but he finds it impossible to perform them all. He welcomes the assistance of the turbine service engineers and the entire group maintains a constant watch for the slightest indication of trouble. Vibration meters and various pressure gages showing oil and steam pressures are watched closely. The speed is increased in slow steps until the machine reaches normal operating speed. Operation is smooth and quiet and the machine is apparently in perfect balance. The rotor floats freely without any indications of rubbing on the outer casing indicating that the thrust bearing clearances are satisfactory. Condenser hogging jets are placed in service to exhaust the air from the condenser shell and these jets add to the steam load on the boiler which has been increasing as the turbine was speeded up.

At normal operating speed the governor mechanisms are adjusted to hold the speed constant and some time is spent in observing governor operation under no-load conditions. The governor is then blocked open and the throttle valve is opened in order to overspeed the machine. The over-speed trip is operated manually on the first trial but adjustments are quickly made so that this trip will operate at a predetermined speed to close the throttle valves shutting off steam to the turbine in case of a governor failure which would permit the machine to over-speed and perhaps wreck itself. After each trial the operator quickly resets the tripping device and opens the throttle valve in order to keep the machine rotating. A number of trials are made before the turbine engineers are satisfied that the governor mechanism and over-speed trip are in perfect adjustment. The variation in steam flow during these trials is of considerable magnitude and is causing the boiler operator some concern.

Holding the Load

The boiler operator is having considerable difficulty in trying to keep the steam pressure within the desired range. Firing the pulverizer intermittently he attempts to meet the demands of the turbine for steam. On several occasions he has added water to the boiler using the emergency hand feed valve in order to keep the water visible in the gage glass and this with his other duties keeps him so busy that he begins to

wonder if one man could possibly keep up with the multitude of details involved in such a period of unstable operation. The service engineer noting that the operator has all that he can do to just handle the intermittent firing of the pulverizer assigns a man to watch the water level and to feed water to the unit by hand. Men are also assigned to check and adjust the feedwater regulating valve and to place it in service as soon as possible after steady steam flow conditions are established.

The boiler operator begins to wonder if the turbine men are ever going to make up their minds. Suddenly the telephone rings and it is the turbine operator calling to inform him that the generator is to be syncronized and placed on the line. He barely has time to turn back to the control panel when the high water alarm on the water column whistles shilly indicating a sudden surge in steam flow from the top drum. The startled water tender is frantically trying to close the hand feedwater valve, but the service engineer quickly instructs this man to leave the valve open for the next few seconds. As the initial surging action of the steam on the water level subsides and steam flow is established at a higher rate the water level begins to drop rapidly and the water tender is forced to spin the hand valve open wide in order to keep the water level showing on the bottom of the gage glass.

The operator is busy with his own problem of adjusting the firing rate of the pulverizer to meet the increased demand for steam. He silently congratulates himself on being lucky in that the pulverizer was in service when the steam flow suddenly increased. He opens the induced draft fan damper and the forced draft fan damper in the order named to give more air to the burner. He then increases the primary air flow to the pulverizer in order to bring more powdered coal to the burner to increase the firing rate. He spends some time adjusting his fuel and air to the burner before he finally arrives at a firing rate which will approximately maintain the desired steam pressure. The steam flow to the turbine is now stable as the generator load has been blocked at a predetermined value which will provide an opportunity for adjustment of automatic controls on both the turbo-generator and the boiler unit.

Checking Controls

The feedwater regulator is quickly adjusted after steady steam flow conditions are attained. It is allowed to cut into service slowly as the hand feedwater valve is closed. A few minutes of uneven water level conditions results with both the high and low water alarms sounding but the regulator is quickly brought into range even though it carries the water level too high in the top drum. During the next hour the adjustment of this regulator continues until the water level finally holds at the center line of the top drum which is considered the normal water level. The superheater drains and all drains in the main steam line are closed when all signs of condensate have disappeared and when steady steam flow conditions have been assured. The succeeding hours are spent adjusting automatic control equipment and checking recorders and instruments. The furnace draft controller is placed in service to maintain 0.1 to 0.2 in. of furnace draft but the service engineer insists that the other automatic combustion controls be emitted from service until each operator becomes familiar with operation of the unit on manual control. This experience is necessary so the operators will know what to do if a control fails and it also gives each operator a better idea of just what function the controller performs during operation.

The visitors of the early morning who watched the initial starting up procedure gradually drift away to the offices and then after lengthy conferences and discussions they leave the plant for various destinations. The plant thus deserted seems to settle down to a routine even though the various electrical and results engineering groups are continuing their endless checking and adjustment of equipment. The load on the generator is increased during the afternoon and additional burners and pulverizers are brought into service. At 50 per cent of maximum load the appearance of the furnace indicates that ignition is stable and that the higher furnace temperature is giving more complete combustion of the coal. The oil burners which have been kept burning to assure ignition in each burner after it was lit off are removed and no trouble is experienced with unstable burner conditions using coal alone. The fly ash laying in the furnace door openings turns from a dark gray to a lighter color as the furnace temperatures increase and the carbon residue in the ash is reduced.

Long hours of hurried yet accurate work finally bring a sense of relief to the tired operating crews as operation continues stable and trouble-free. The erection crews who watched with so much interest the operation of the equipment which they had built, leave during the middle of the afternoon. Relief operating crews appear during the early evening and are coached and instructed in their new duties. The tension of early operation gradually wears off as evening approaches and tired men arrange their work for a few moments of rest during which unestimated gallons of coffee are drunk. Sandwiches are hastily gobbled and a few are tempted to eat pie off the palm of their hand even though the danger of biting a stray finger is ever present. The lack of the proper implements dulls few appetites and appreciation is expressed for the efforts of the men who so thoughtfully arranged to have the food sent into the plant.

"Comes a Pause in the Day's Occupation . . ."

By midnight the day operating crew has left the plant for a few short hours of rest. The tired service engineer, unwilling to delegate the responsibility of operation to his relief engineer, continues on duty. He watches every move of the new operating crew and spends considerable time in instructing the new boiler operator. After giving verbal instructions he has the operator change pulverizers in order that he may become familiar with the actual procedures involved. The proper burner is selected and an oil lighter is lit. The damper or valve in the line from the pulverizer is opened and the furnace draft is increased to —0.5 to —0.6 in. water so as to eliminate any possibilities of a positive furnace pressure which might occur when the coal burner lights off. The burner windbox damper is opened slightly and the operator starts the pulverizer after checking to make sure that the primary air damper to the mill is closed. The coal feeder is started and as previously described is allowed to feed coal to the pulverizer for 2 or 3 minutes. The coal feeder is shut off and then the operator slowly opens the primary air damper and the new burner lights off. The furnace draft gage pointer surges up and down across the scale but ignition soon becomes stable and the furnace draft remains at a negative value. The operator then decreases the air to the pulverizer which is to be removed from service to a minimum established as the low point for stable burner operation on coal. This is done in order to limit the steam pressure rise which would occur if both pulverizers were to continue to feed large amounts of coal to the burners. When the ignition of the coal in the new burner becomes stable and after the service engineer completes his preliminary setting of the coal feeder on the new pulverizer then the original pulverizer is shut down.

The pulverizer is shut down in the normal way. The cold air valve is used to temper the hot primary air to the pulverizer so that the temperature of the coal-air mixture leaving the pulverizer does not exceed 160 F is opened wide. At the same time the valve or damper on the hot air line from the burner windbox is closed in order to allow the pulverizer to cool. As the temperature of the coal-air mixture to the burner begin to drop the coal feeder is stopped and in a few minutes the flame of the burner becomes smaller. A momentary increase in flame intensity occurs as the operator slowly opens the primary air damper to allow the cold air to rush through the pulverizer blowing all the powdered coal out of this equipment, thus cleaning it before shutting down. The burner flame now dies out completely and the watchful operator quickly closes the primary air damper and stops the pulverizer. Since this machine is going to be down for some time he closes the damper in the coal-air line from the pulverizer to the burner. After a few trials the new operator secures a satisfactory adjustment of the firing rate of the pulverizer which will hold steam pressures without requiring his constant attention and he soon has his air and furnace draft es-

(*Continued on Page 107*)

The Gas Turbine Power Plant—II

By JOHN I. YELLOTT

Director of Research, Locomotive Development Committee, Bituminous Coal Research, Inc.

How to make calculations for estimating plant performance . . . Characteristics of air, the working fluid, shown by gas charts and diagrams, giving relations of pressure, temperature and enthalpy . . . How to calculate compressor work and "back work" . . . How reduce this work . . . How much water for intercooling, if used . . . How figure heat added in regenerator and combustor . . . How to calculate work done by turbine . . . Effects of pressure loss . . . Value of intercooling, additional regenerator surface . . . How to recalculate cycle to take account of losses, pressure changes, etc.

BEFORE discussing in detail the components of the gas turbine power plant, it is desirable to be able to make the relatively simple calculations involved in estimating plant performance. Fortunately, the working fluid is atmospheric air. Even after the fuel has been burned in the combustor, the heated air still possesses essentially the same properties as if it were still pure air. Only in refined calculations, where great accuracy is required, must correction be made for the presence of the combustion products in the turbine air.

The closed cycle plant can use any suitable gas as its working fluid. Since the heat is added indirectly, the gas undergoes no dilution or contamination and its properties remain unchanged. Because air is the working fluid universally used at present in both open and closed cycles, this discussion will be limited to it.

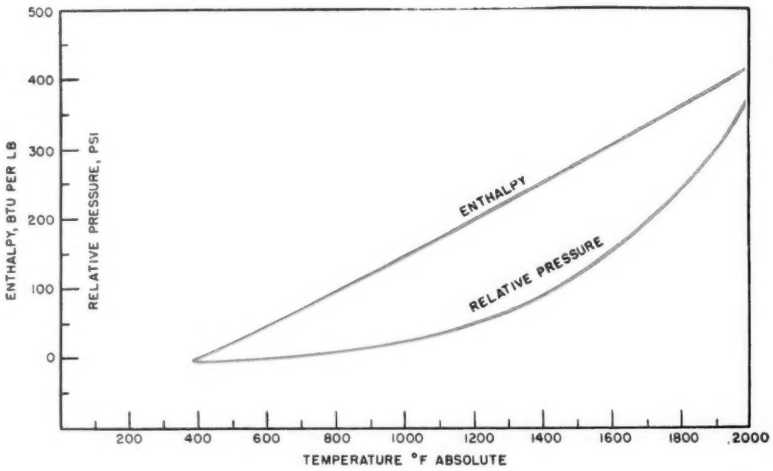


Fig. 1—Left. Enthalpy and relative pressure of air as a function of absolute temperature
Fig. 2—below, Left—Gas turbine cycle on p-v plane
Fig. 3—below, Right—Gas turbine cycle on h-s plane

Properties of Air

A number of sources exist from which the properties of air can be obtained. Keenan and Kaye's *Thermodynamic Properties of Air* (John Wiley, New York, 1945), is as authoritative and essential for gas turbine calculations as the earlier *Thermodynamic Properties of Steam*, by

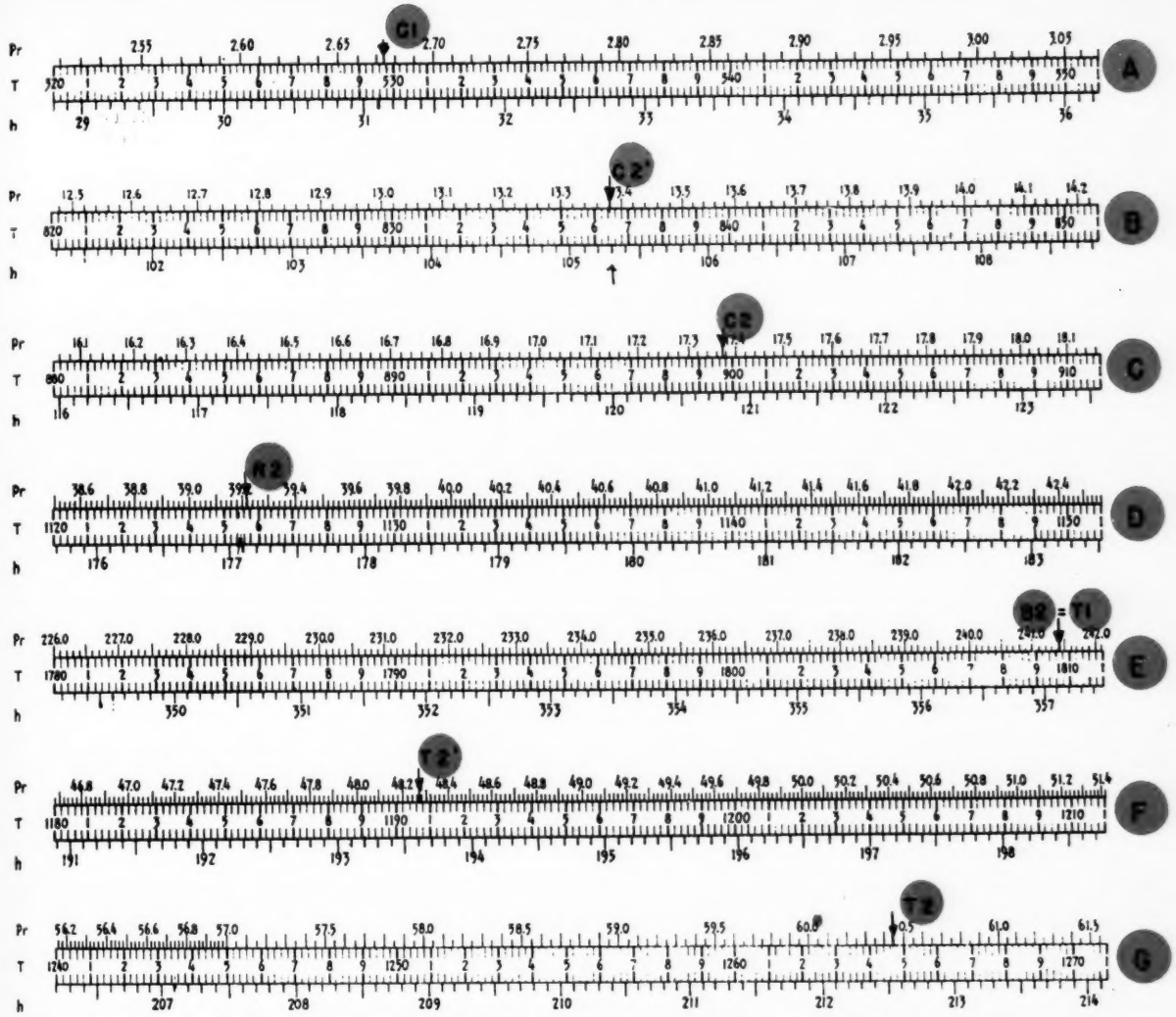


Fig. 4. Sections of Gas Turbine Gas Charts (Bureau of Ships, U. S. Navy). Now available from Superintendent of Documents, U. S. Government Printing Office, Washington D. C.

Keenan and Keyes (John Wiley, 1936), is for the steam plant. A convenient graphical presentation of the Keenan and Kaye data is contained in *Gas Turbine Gas Charts*, prepared by Amorosi and Todd of the Research Branch, Bureau of Ships, Navy Department. The Allis-Chalmers Mfg. Co. has for some years used a Mollier diagram for air that was prepared under the supervision of Dr. J. T. Rettaliata. A simplified form of this chart is presented as Fig. 5. Each of these sources of data will be utilized in this series, although the *Gas Charts* will be used most frequently because of their convenience. Fig. 4 gives several selected sections which will be particularly useful.

Since air is essentially a perfect gas, its properties can be calculated much more easily than those of steam or other vapors. The specific volume and its reciprocal, the specific weight, are found from the familiar gas law:

$$144\ pv = RT \qquad (1)$$

Thus, at 70F (529.6 *Rankine*), and 14.7 psia,

$$v = (53.3 \times 529.6) \div (144 \times 14.7) = 13.35 \text{ cu ft per lb}$$

The enthalpy, h, of air depends only upon its temperature, and a simple, virtually linear plot of enthalpy can be made

All rights of re-publication reserved by the author. This series of articles, following publication in these pages, will appear in a forthcoming book to be published by John Wiley & Sons, New York.

Part I of this series, in the January issue, discussed the various cycles and equipment available for the practical gas turbine power plant; showed how to make preliminary calculations of performance for a 5000-hp plant and how it would compare with a 5000-hp steam power plant; discussed existing plants as guides to future design. Future articles in the series will give specific calculations for turbines, compressors, combustors and auxiliaries, part-load performance, operation and control of plant, physical and economic comparison of gas turbine and steam plants.

TERMINOLOGY USED IN GAS TURBINE CALCULATIONS

- p = pressure, lb per sq inch absolute
- p_r = relative pressure, psi
- v = specific volume, cu ft per pound
- t = temperature, °F
- T = absolute temperature = 459.7 + t = °R (that is, degrees Rankine, the name given to the absolute temperature scale in degrees Fahrenheit)
- c_p = specific heat at constant pressure, Btu per lb per degree
- c_v = specific heat at constant volume, Btu per lb per degree
- R = gas constant = 53.345 ft lb per degree F
- k = exponent of isentropic expansion = $c_p \div c_v$
- r = pressure ratio = $p_2 \div p_1$
- h = enthalpy, Btu per pound
- Δh = change in enthalpy during a real process
- Δh_s = isentropic change in enthalpy
- E_C = compressor efficiency
- E_T = turbine efficiency
- q_B = combustor heat release, Btu per lb. of air
- Q_B = combustor heat release, Btu per hr.
- E_B = combustor efficiency
- W_f = fuel supplied, lb per hr.
- C = compressor (when used as a subscript)
- B = combustor (when used as a subscript)
- T = turbine (when used as a subscript)

in terms of temperature alone, as in Fig. 1. The entropy of air depends upon pressure as well as temperature, and so the simplest way of combining these three properties is the Mollier chart of Fig. 5. Entropy is rarely used in plant calculations, and its principal value is in the showing of an actual cycle on the Mollier diagram. Keenan and Kaye explain the calculations involved in computing changes in entropy.

Since the combustion gas turbine is essentially a steady flow process, the energy quantity involved in each step can be expressed in terms of the change in enthalpy of the air. These changes can be read from the Mollier chart or, if greater accuracy is needed, they can easily be computed in the manner explained in the following paragraphs. The "relative pressure" function of Keenan and Kaye is explained on p. 57 of their tables of the properties of air.

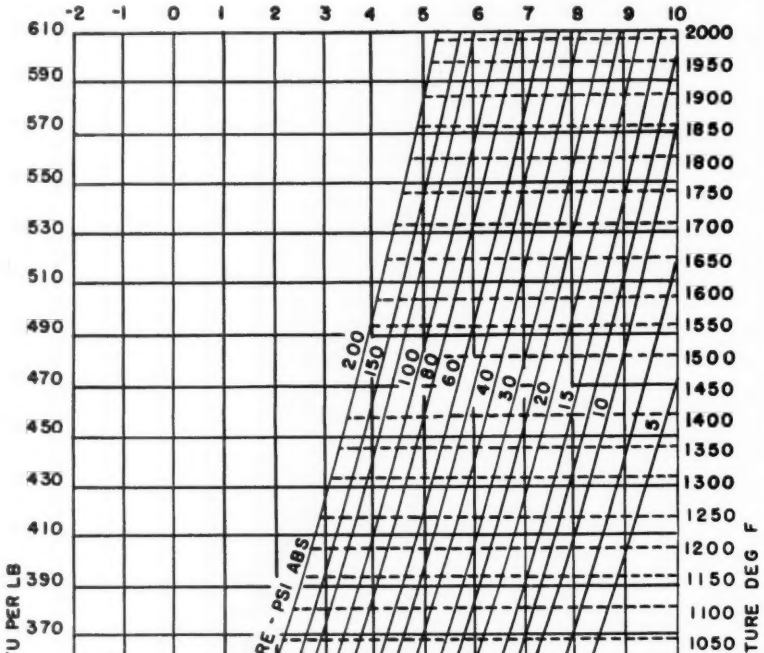


Fig. 5. Mollier and temperature-entropy chart for air, adapted from *Current Trends*, No. 7, Allis-Chalmers Mfg. Co.

On this chart, the 0 value of enthalpy occurs at -459.7 F (0 degrees R). Note that values of enthalpy do not agree with those of Keenan and Kaye, for which the 0 Value of enthalpy occurs at -59.7 F. Differences in enthalpy will be the same, however.

How to Calculate Air Changes

The gas turbine power plant operates on the Brayton cycle, shown in Figs. 2 and 3 for a single pound of dry air. Taking the initial condition, C1, at 70F, 14.7 psi a, the specific volume has already been shown to be 13.35 cu ft per lb, and the enthalpy is found from the *Gas Chart*, Fig. 4A, at T_{C1} = 529.7 R, to be 31.12 Btu per lb. There is no purpose in carrying these values to more than one decimal place, so they will be rounded to the nearest tenth of a Btu per lb. The relative pressure, p_r, at point 1, is 2.674 psi.

The first process in the Brayton cycle is the compression of the air to some higher pressure, P_{C2}. The choice of the pressure ratio, r, where $r = p_{C2} \div p_{C1}$, is dependent upon a number of variables which will be discussed later in this section. An arbitrary choice of a 5 to 1 pressure ratio will be made here, thus fixing p_{C2} at $5 \times 14.7 = 73.5$ psia. If the compressor were perfect, which unfortunately is not the case, the process would be isentropic and point C2′ would have a relative pressure of $5 \times 2.674 = 13.370$ psi. The enthalpy and temperature which would prevail at this imaginary point are obtained from the *Gas Chart* at $p_r = 13.370$, Fig. 4B; T_{C2} = 836.2 R, t_{C2} = 376.5; h_{C2} = 105.2 Btu per lb. The specific volume at C2′ would be $(53.3 \times 836.2) \div (144 \times 73.5) = 4.22$ cu ft per lb.

There are other ways of computing the conditions after an isentropic compression, and any of the standard text books on thermodynamics explains them in detail. The method of Keenan and Kaye, using the "relative pressure," is the simplest and most foolproof and so it is used here.

How to Calculate Compressor Work

The work which the ideal compressor would do on each pound of dry air is equal to the change of the enthalpy of the air during the process, Δh_{sC}.

$$\Delta h_{sC} = h_{c2} - h_1 = 105.2 - 31.1 = 74.1 \text{ Btu per lb} \quad (2)$$

The ideal rise in temperature, Δt_{sC}, is

$$\Delta t_{sC} = 836.2 - 529.7 = 306.5 \text{ F} \quad (3)$$

It is interesting to note that the average value of the specific heat at constant pressure, c_p, during this temperature interval is $74.1 \div 306.5 = 0.242$ Btu per lb per degree.

A real compressor will have some losses, both internal and external, which will cause the rise in both temperature and enthalpy to be greater for a given pressure ratio than the ideal values. Measurement of the actual temperature rise is the most accurate method of determining the "internal efficiency" of a compressor, just as measuring the temperature drop across a turbine allows its internal efficiency to be computed. If the compressor efficiency is assumed to be 85 per cent, a value which is exceeded slightly by the best modern axial units, the following results are obtained:

$$\Delta h_C = 74.1 \div 0.85 = 87.3 \text{ Btu per lb} \quad (4)$$

Then h_{C2}, the enthalpy at the actual compressor outlet, is 31.1 + 87.3 = 118.4 Btu per lb and the temperature is ap-

Table I. Comparison of compressor power requirements 5 to 1 compression ratio from 70 F, 14.7 psi; 50,000 cfm

E_C	1.00	0.90	0.88	0.86	0.85	0.84	0.83	0.82	0.81	0.80	0.78
Δh_C	74.1	82.4	84.3	86.2	87.3	88.3	89.4	90.4	91.6	92.7	95.1
hp	6,540	7,270	7,450	7,610	7,720	7,800	7,890	7,980	8,100	8,190	8,400
E_C	0.76	0.74	0.72	0.70							
Δh_C	97.5	100.1	103.0	106.0							
hp	8,610	8,850	9,100	9,360							

proximately

$$t_{C2} = t_{C1} + (306.5 \div 0.85)$$
$$= 70.0 + 361.0 = 431.0 \text{ F} \quad (5)$$

so $v_{C2} = (53.3 \times 890.7) \div (144 \times 73.5)$
$= 4.48$ cu ft per lb (6)

If the compressor has a free air capacity of 50,000 cfm, $(50{,}000 \times 60) \div 13.35$ = 225,000 lb air per hr, the power delivered to the air within the compressor will be

$$(225{,}000 \times 87.3) \div 2545 = 7{,}720 \text{ hp} \quad (7)$$

The friction in the bearings of the compressor, the power required by the bearing oil pump, and similar minor losses should be added to this internal power to obtain the shaft power that must be delivered to keep the compressor running. About one-half of one percent of the internal power will be needed to supply these mechanical losses, thus raising the compressor power to $7{,}720 \div 0.995 = 7{,}750$ hp.

"Back Work," Why Important, How Figure It

The importance of the "back work" required to operate the compressor should be thoroughly understood, for it was this problem which defeated the early gas turbine builders. Without an efficient compressor, the "back work" can easily exceed the turbine output. Table I shows the values of the power required in Btu per lb and in hp for a 50,000-cfm intake, as the compressor efficiency is varied from the unattainable ideal of 100 per cent down to a minimum useful value of 70 per cent.

While the compressor is being considered, it is desirable to mention other feasible methods of reducing the back work. The atmospheric temperature influences the enthalpy change for a given pressure ratio in accordance with the fundamental equation for the work required in an isentropic compression:

$$\Delta h_{sC} = k\, RT_1 [1 - r^{(k-1) \div k}] \div (k - 1) \quad (8)$$

For the five-to-one compression ratio which is under consideration, it can be seen that the compressor work in Btu per lb varies directly as the absolute temperature of the intake air. The isentropic exponent k is essentially a constant, since it varies only one percent, from 1.401 to 1.386, as the air temperature changes from −259.7 F to 440.3 F. (See Keenan and Kaye, p. 36). The gas constant for air, R, is independent of temperature. Figure 7 shows the temperature after compression from 70 F for various pressure ratios and compressor efficiencies.

How to Reduce Compressor Work

Reducing the inlet air temperature from 70 F to 0 F lowers the ideal compressor work from 74.1 Btu per lb to $459.7 \times 74.1 \div 529.7 = 64.3$ Btu per lb. The sub-zero temperatures encountered in high altitudes or in very severe winter weather produce cycle efficiencies which are quite interesting when compared with other prime movers. At −60 F, the ideal compressor work becomes:

$(399.7 \times 74.1) \div 529.7 = 56.0$ Btu per lb.

The atmospheric temperature is not yet subject to control, but there are other methods by which the compressor work can be reduced. If isothermal compression could be attained, the work would be reduced to the theoretical minimum. No isothermal compressor has yet been devised, but a reasonable approximation can be made by intercooling or by water injection. The latter system holds particular promise for improving gas turbine plant performance when the ambient temperature rises beyond the design value. Spraying water into the compressor reduces the work requirement per lb by diminishing the air temperature within the unit; and, simultaneously, working fluid is added without additional compression work. A discussion of water injection will be included in a later article.

How Calculate Water for Intercooling

Intercooling is the accepted method of reducing the power required to compress large quantities of air. The amount of cooling water needed is not excessive, and the extent of surface needed to obtain a considerable temperature reduction is also reasonable. In the cycle under consideration, let us assume that an intercooler is installed between two efficient axial compressors. The pressure ratio in the first stage will be $\sqrt{5} = 2.24$; the pressure will rise from 14.7 to 33 psia, while the second stage will handle the rise from 33 to 73.5 psia.

Repeating the same type of calculation that was followed for the original compressor, and designating the discharge condition from the first stage by C2, used as a subscript, with a prime to denote the ideal condition, we have the calculations shown in table II.

The total compressor power = 3,490 + 3,420 = 6,910 hp, which is a reduction of 810 hp below the requirement of a single-stage, 85 per cent efficient compressor. The heat taken away by the intercooler is $225{,}000 \times (69.8 - 33.5) = 8{,}170{,}000$ Btu per hr. As a rough approximation, the amount of water required per hour, assuming a 20-F temperature rise, would be 408,000 lb or about 816 gpm.

As a comparison with this water requirement, a 4000 hp (3000 kw) steam plant would have to reject about 30,000,000 Btu per hr in its condensers, which, with the same 20-F temperature rise in the circulating water, would need about 3000 gpm.

How to Figure Heat Added in Regenerator and Combustor

The amounts of heat added to the air in the regenerator, R, and the combustor, B, are in each case equal to the change in enthalpy. Referring to the Mollier diagram Fig. 5 for the simple cycle which is under discussion, Fig. 2, let it be assumed first that no regenerator is used. The combustor will have to heat the air from the compressor outlet condition to the temperature at which the air will be delivered to the turbine, 1350 F. The heat added in the combustor is found from

$$\Delta h_B = h_{T1} - h_{C2}$$

From the *Gas Charts*, at 1350 F, 1809.7 R $h_{T1} = 357.1$ Btu per lb. Returning to the compressor efficiency of 85 per cent used in equation (4), $h_{C2} = 118.4$ Btu per lb. The heat added in the combustor is $357.1 - 118.4 = 238.7$ Btu per lb.

The efficiency of the gas turbine cycle can be materially increased by recovering a portion of the heat in the turbine exhaust, and returning it to the air as it enters the combustor. If the compressed

Table II. Re-calculation of cycle to show effect of intercooling in reducing compressor work

$p_{rC2} = 2.24 \times 2.674 = 5.98$ psi (9)
so $h_{C2'} = 64.0$; $h_{C2'} - h_1 = 64.0 - 31.1 = 32.9$ Btu per lb
$t_{C2'} = 666.3 - 459.7 = 206.6$ F; $\Delta t_{sC} = 136.6$ F
$v_{C2'} = (53.3 \times 666.3) \div (144 \times 33) = 7.48$ cu ft per lb
If the first compressor has an internal efficiency of 85 percent
$h_{C2} - h_{C1} = 32.9 \div 0.85 = 38.7$, so $h_{C2} = 69.8$ Btu per lb
$t_{C2} = 70 + 136.6 \div 0.85 = 70 + 160.6 = 230.6$ F
$v_{C2} = 7.48 \times 690.3 \div 666.3 = 7.76$ cu ft per lb
Compressor power = $225{,}000 \times 38.7 \div 2545 = 3{,}420$ hp
Assuming that cooling water is available at a temperature low enough to cool the compressed air back to 80 F, and neglecting the minor pressure drop in the air side of the intercooler, the second stage of the compressor yields the following:
p_{rC3} = "relative pressure" at (459.7 + 80) = 539.7 R = 2.855 psi
$p_{rC4} = 2.24 \times 2.855 = 6.40$ psia
$h_{C4'} = 67.1$; $\Delta h_{sC} = 67.1 - 33.5 = 33.6$ Btu per lb
$t_{C4'} = 679.1 - 459.7 = 219.4$, $\Delta t_{sC} = 139.4$
$v_{C4'} = (53.3 \times 679.1) \div (144 \times 73.5) = 3.42$ cu ft per lb
If the second stage compressor also has an efficiency of 85 percent, then
$h_{C4} = 33.5 + (33.6 \div 0.855) = 33.5 + 39.5 = 73.0$ Btu per lb
$t_{C4} = 80 + (139.4 \div 0.85) = 80 + 164 = 244.0$ F
$v_{C4} = 3.42 \times 703.7 \div 679.1 = 3.54$ cu ft per lb
Compressor power = $(225{,}000 \times 39.5) \div 2545 = 3{,}490$ hp

Table III. Effect of Turbine Efficiency upon Exhaust and Enthalpy
Inlet temperature, 1350 F, 73.5 psia, 5 to 1 pressure ratio

E_T	100.0	92.0	90.0	88.0	86.0	84.0	82.0	80.0
t_{T2}	731.0	781.9	795.1	807.5	820.9	834.0	846.0	858.3
Δh_T	163.5	150.5	147.1	143.9	140.5	137.1	134.0	130.8

air is directed through tubes over which the hot exhaust flows, the air temperature can be raised to a value which approaches that of the exhaust. The air, of course, can never be made hotter than the turbine exhaust, while the exhaust cannot be cooled below the compressor outlet temperature. The relationship between the actual temperature drop of the exhaust and the maximum possible drop is known as the "effectiveness" of the regenerator. Effectiveness values of 50 to 75 per cent can be attained without exceeding reasonable dimensions.

If the regenerator heats the air to 666 F, 1125.7 R, then h_{R2} = 177.1 Btu per lb. The heat picked up by each pound of air in the regenerator is the change in enthalpy.

$\Delta h_R = (h_{R2} - h_{C2}) = 177.1 - 118.4 =$ 58.7 Btu per lb

The combustor must now heat the air from 666 F to 1350 F, and the heat added per lb is again equal to the change in enthalpy.

$\Delta h_B = h_{B2} - h_{R2} = 357.1 - 177.1$ = 180.0 Btu per lb

It is immediately recognized that the use of the regenerator has reduced the amount of fuel needed per pound of air by about 25 per cent. In passing, it is interesting to note that the average specific heat of the air in the combustor is 180.0 ÷ (1350 − 666) = 180.0 ÷ 684 = 0.263 Btu per lb.

Calculation of Work Done by Turbine

The work done on the turbine blades by the expanding air can now be computed, using the fact that the energy available for doing work is the isentropic change in enthalpy. This quantity is found by reversing the procedure followed for the compressor. Neglecting temporarily the loss in pressure which has occurred as the compressed air passed through the regenerator and the combustor, p_{T1} remains at 73.5 psi a, t_{T1} = 1350 F, h_{T1} = 357.1 Btu per lb. Referring again to the gas charts, $p_{T'1}$ = 241.35 psi. The expansion ratio, neglecting pressure losses, is still 5.0, so the relative pressure after the isentropic expansion is 241.35 ÷ 5.0 = 48.27 psi. From the *Gas Charts*, we find $T_{T2'}$ = 1190.7 R, $t_{T2'}$ = 731.0 F, $h_{T2'}$ = 193.6 Btu per lb. Thus, the energy available for work in the ideal turbine is

$\Delta h_{aT} = h_{T1} - h_{T2'} = 357.1 - 193.6$ = 163.5 Btu per lb and Δt_{aT} = 1350.0 − 731.0 = 619.0 F.

The turbine will have some internal losses, and so the actual work per pound of air will be less than that theoretically available. The turbine efficiency, E_T, is the ratio of the work actually done per lb of air to the work available. Table III shows how the actual work varies as the turbine efficiency is reduced to reasonable values. The actual temperature drop in the turbine is likewise the theoretical or ideal drop multiplied by the efficiency. For a turbine efficiency of 88 percent,

$\Delta h_T = 0.88 \times 163.5 = 143.9$ Btu per lb
$\Delta t_T = 0.88 \times 619.0 = 545$ F

Effects of Pressure Loss

The effect of pressure loss is by no means negligible, and it can readily be calculated. If there is a loss of 2.0 psi from the compressor discharge to the turbine inlet, and if there is a further drop of 0.2 psi as the exhaust passes through the regenerator, then the pressure ratio becomes (73.5 − 2) ÷ (14.7 + 0.2) = 4.81. The relative pressure after the ideal turbine would thus be 241.35 ÷ 4.81 = 50.2. The enthalpy would be 196.8 Btu per lb and the temperature would be 1203.2 R = 743.5 F. The energy available for the ideal turbine would be 357.1 − 196.8 = 160.3 Btu per lb. Thus, a pressure drop of 3.0 per cent of the original 73.5 psia has caused a reduction of 2.0 per cent in the available energy.

The cycle efficiency can now be calculated, if a consistent set of assumptions is made. First, assume a compressor efficiency of 84 per cent which is conservative in the light of present data on multistage axial units. From Table I, the temperature rise in the compressor to point C2 is 366 F, and the enthalpy rise is 88.3 Btu per lb. Accordingly, t_{C2} = 436 F, and $h_{C2'}$ = 119.5.

If the regenerator is temporarily omitted, the cycle efficiency and its air rate (pounds of air circulated per shaft hp-hr) can be calculated in the following manner, taking 0.86 as the turbine efficiency.

Δh_T = heat available per lb = 140.5 − 88.4 = 52.1, Btu per lb
AR = Air rate, lb per shaft hp hr = 2545 ÷ 52.1 = 48.9
Δh_B = Heat added in combustor, Btu per lb = 357.1 − 119.5 = 237.6
E_{cycle} = Cycle efficiency = (52.1 ÷ 237.6) × 100 = 22.0 percent

The usefulness of the regenerator becomes apparent when the cycle efficiency is recalculated, and the heat added in the combustor is reduced to the value of 180 Btu per lb which was derived earlier. The compressor work and the turbine power will not change although the regenerator pressure loss must be considered, as it will be in a subsequent calculation. The regenerative cycle efficiency thus becomes E_{cycle} = (52.1 ÷ 180) × 100 = 29.0 percent. This gain from 22.0 to 29.0 per cent, or 7.0 percentage points, is usually worth its price in added first cost of the station.

How to Recalculate Cycle to Take Account of Losses, Pressure Changes, etc.

In order to be realistic, the efficiency of the cycle will now be recalculated using the reduced turbine inlet pressure, and the increased turbine back pressure, which will actually exist. Once more, the compressor work remains unchanged and the heat added in the combustor stays at 180.0 Btu per lb. However, the turbine now has only 160.3 Btu per lb available. At 86.0 per cent turbine efficiency, the actual energy drop is 0.86 × 160.3 = 138.0 Btu per lb. The new net shaft power is (138.0 − 88.4) = 49.6 Btu per lb of air, and the new air rate is 2545 ÷ 49.6 = 51.3.

The new cycle efficiency is (49.6 ÷ 180.0) × 100 = 27.6 per cent. In short, a loss of 2.0 psi on the high-pressure side of the cycle, and 0.2 psi on the exhaust side, or (2.2 ÷ 73.5) × 100 = 3.0 percent, has cost (1.4 ÷ 29.0) × 100 = 4.8 per cent in cycle efficiency. Evaluation of the regenerator must take into account the pressure loss on both high and low

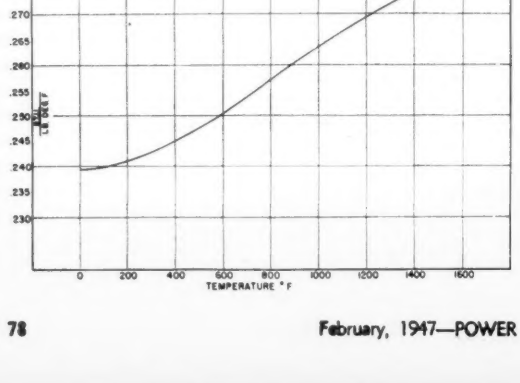


Fig. 6—Left. Specific heat of air at constant pressure

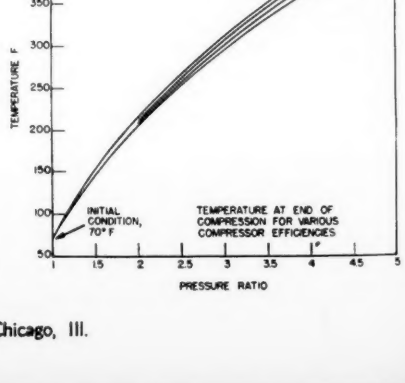


Fig. 7—Right. Temperature of air at the end of compression for various compressor efficiencies

sides of the cycle, but the gain usually far outweighs the cost.

Assuming that the turbine in the current example receives all of the 225,000 lb of air which are furnished by the compressor, the internal power of the turbine would be, at 86 per cent efficiency

Int. Turbine Power =
$(225{,}000 \times 0.86 \times 160.3) \div 2545$
= 12,180 hp.

Assuming a 1.5 per cent loss due to the turbine bearings, governor drive, oil pump, etc., the actual turbine power is 12,000 hp. The net output of the plant would therefore be the actual turbine power minus the total compressor power, or 12,000 — 7,750 = 4,250 hp.

A further analysis of the losses to be encountered in the real cycle, as distinguished from the theoretical, reveals that the combustor can hardly be expected to burn the fuel completely. If 97 per cent of the heating value of the fuel is released, the cycle efficiency becomes $27.6 \times 0.97 = 26.8$ per cent. Also, some auxiliaries must be included, such as fuel oil pumps, lubricating oil pumps, and, in the case of the coal-burning turbine, the equipment needed to process the coal. About 3 per cent of the shaft output should be allowed for the solid-fuel handling equipment, or 1 per cent for oil. The efficiency of the actual plant can reasonably be expected to be between 26.0 and 26.5 per cent.

How to Figure Value of Intercooling, More Regenerator Surface, Etc.

Any number of variations of the fundamental open cycle can be developed, and marked improvements in efficiency can be accomplished by intercooling, increasing regenerator surface, or reheating. Analysis of the equations for cycle performance make clear the possibilities of each process.

Air rate = $2545 \div (\Delta h_{aT} \times E_T - \Delta h_{aC} \div E_C)$

Cycle efficiency = $\Delta h_T \div \Delta h_a$

Raising the turbine inlet temperature, and lowering the exhaust temperature, increases the heat available to the turbine, Δh_{aT}. Obviously, raising the turbine efficiency is beneficial. Reducing the compressor work by using colder air, and raising the compressor efficiency, is doubly desirable, because it reduces the air rate and hence the size of the equipment, and it also increases the net output for a given size of turbine.

As an example of the gain from intercooling, consider the cycle performance when the two-step compressor previously discussed is used. Neglecting for the moment the probable minor change in the regenerator performance due to the somewhat lower compressor outlet temperature, the power delivered by the turbine will increase to

Net Power = 12,000 − 6,910 = 5,090 hp
Cycle Efficiency = $[100 \times (5090 \times 2545)] \div (225{,}000 \times 180.0) = 32.0$ per cent

The calculation of the cycle efficiency of any gas turbine plant can be accomplished without excessive difficulty by following the procedure just explained. Any combination of regenerators, combustors, turbines, compressors, and intercoolers can be assumed, but it will be found that the simpler arrangements have much to be said in their favor. Many analyses of gas turbine performance have been made, one of the most useful being that by Professor C. R. Soderberg of Massachusetts Institute of Technology and R. R. Smith of Elliott Company, published in POWER PLANT ENGINEERING for April, 1944. Figure 8, reproduced from that publication, shows in a simple but convincing manner the possibilities of the open cycle for turbine inlet temperatures of 1200 F, 1350 F, and 1500 F, with regenerator efficiencies of 0, 50 per cent, 75 per cent, and 90 per cent. In their calculations, reasonable values of the efficiencies of the components were assumed. For 1350 F turbine inlet temperature, for example, the pressure ratio at highest efficiency goes down as the effectiveness of the regenerator goes up. With no regenerator, the cycle efficiency continues to increase with rising pressure ratios up to about ten to one. With a 50 per cent effective regenerator, the optimum pressure ratio is five to one, and the cycle efficiency would be about 27 per cent. Increasing the area of the regenerator boosts the cycle efficiency above 30 per cent, but the rate of gain drops off as the regenerator effectiveness exceeds 75 per cent.

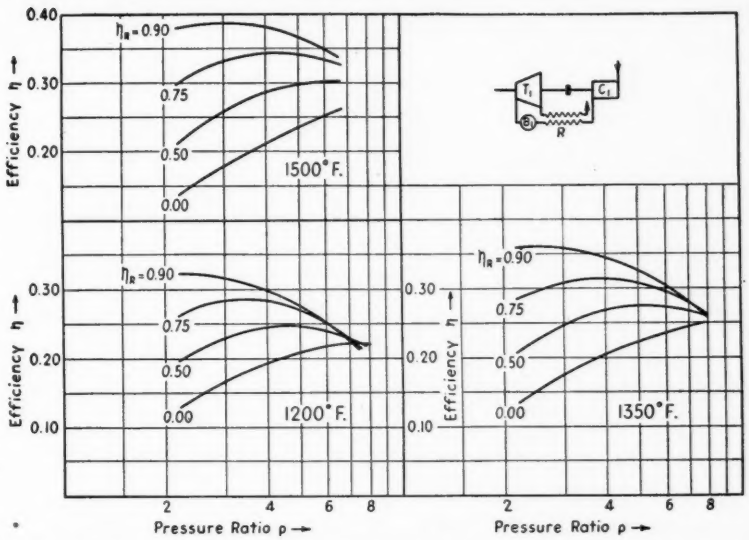


Fig. 8. Gas Turbine cycle possibilities. Efficiencies at various temperatures for the cycle shown in the diagram, for various regenerator efficiencies denoted by η_R

To summarize the matter of gas turbine plant performance, the simple cycle gives efficiencies in the 20 per cent range. Adding the regenerator boosts the effiiciency towards 30 per cent, and this figure can be exceeded by using intercooling and reheat. The value of these refinements must be weighed carefully, however, for one of the principal attractions of the gas turbine plant is its simplicity.

(To be continued)

CONSTRUCTION program on the Bureau of Reclamation's million-acre Columbia Basin Irrigation Project in Eastern Washington will be expanded as a result of President Truman's relaxation of restrictions on expenditures by the agency. Approximately $25,000,000 in dams, canals, siphons, and heavy machinery are in the Bureau's "pending" files, and awards of contracts covering these items will be made "as rapidly as feasible and within the limits of the Bureau to meet progress payments as authorized work proceeds," commented District Engineer Frank A. Banks. A self-liquidating multiple-purpose development, the Columbia Basin Project ultimately will serve 12,000 to 15,000 irrigated farms of veterans and other settlers. Work on some irrigation structures in the Basin began last summer. The construction moratorium, called nearly three months ago, did not affect work on several key structures in the multi-million-dollar irrigation system, such as the 10,000-foot South Dam, the gigantic Bacon Tunnel, a portion of the West Canal, the river-size Main Canal, and the Pasco Pumping Plant and distribution system. In the Pasco area, where a pumping plant and lateral system are being built, 5,400 fertile acres will receive water in 1947-48, the Bureau reported. This acreage will be divided into approximately 80 family-size farm units. Among the jobs on which the Bureau has opened bids, but has not announced contracts are: Potholes Dam, $9,359,011; Long Lake Dam, $1,770,592; aggregates at Adrian, Wash., for concrete structures, $373,612; portion of the East Low Canal, $3,977,136; six 65,000-hp electric motors for the Grand Coulee Dam; Pumping Plant to serve the irrigation system, $2,475,548; discharge pipes for Pumping Plant, $1,271,854; and three turbines and generators for the now vacant East Powerhouse, $5,581,517.

XUM

ATOMICS

A New Section added to POWER PLANT ENGINEERING to cover current and forthcoming developments in atomic energy and related developments and applications in Nuclear Physics

Eee Equals Em See Squared

The practical significance of the Einstein equation . . . The production of Helium from Hydrogen . . . Binding energies . . . Binding energies of the various elements in the periodic table . . . Conditions necessary for liberation of nuclear energy in the light nuclei . . . The nature of nuclear energy reaction in the sun and stars

By **ANDREW W. KRAMER** Managing Editor, Power Plant Engineering

JUST ABOUT A YEAR AGO at this time, a small group of men, seven of them, were actively engaged in the study of atomic energy. Of course, many other people in the world were studying the same thing but this particular group was unique in that they did nothing else, night and day, for over two months. They lived, talked and almost slept atomic energy—sometimes they discussed it continuously for 18 hrs a day. These were the men who comprised the Board of Consultants, appointed by the State Department to study the subject of the control of atomic energy. At the time the Board was appointed the United Nations Assembly was considering a proposal that an international atomic energy commission be formed but no action had been taken. The State Department, however, presumed, rightly, that the problem was so important that the Assembly would not long delay approval of the idea. Accordingly, it decided to institute an American study of the project for worldwide atomic control, so that when an international commission was set up and ready to consider the matter, the American representative would have a sound course of procedure to offer the representatives of other nations. It was to make this study that the Board of Consultants was appointed, and the result of the study was the Acheson-Lilienthal Report (See POWER PLANT ENGINEERING, June and October 1946).

The study was a peculiar one because the consultants had little idea of where to start and were even more uncertain about where they were going.

The Board was composed of a diversified group of men. Actually it was composed of five men headed by a sixth, Under Secretary of State Dean Acheson himself. In addition there were two others who were a part of the group in an unofficial capacity.

Among the group, the most distinguished from an "atomic" standpoint, was Professor Robert Oppenheimer, who directed the development and design of the atomic bomb at the Los Alamos Laboratory. He used to lecture to the lay members of the Board on the mysteries of nuclear fission and related matters. Quite different, both in temperament and training from Professor Oppenheimer, was Chester Barnard, the president of the New Jersey Bell Telephone Company, a bald, cautious man, who at 59 was the oldest member of the group. Prior to his appointment on the Board, he had never traveled in an airplane. Another was Harry Winne, a vice president of General Electric Co., a first class electrical engineer and business executive of note. They called Winne the unemployed executive because the General Electric strike was on at that time. Then, there was a first-class chemist, by the name of Charles Thomas who was a vice-president of the huge Monsanto Chemical Co. The Board's chairman, David Lilienthal, needs no introduction, he was the director of the Tennessee Valley Authority for many years—an able administrator

Since many people have become casually familiar with the absolute significance of the Einstein equation it is natural for them to ask why Atomic energy cannot be obtained from materials other than uranium. Why can't we convert clay into atomic energy? This article attempts to answer this question. It discusses the nature of nuclear reactions in the lighter atoms, that is, those at the low end of the periodic table and shows why such reactions cannot be made to work here on earth. It is shown that these light nuclear reaction do take place in the sun and stars but that because of temperature and pressure requirements, these nuclear reactions cannot be duplicated on earth. In the sun energy is released in the formation of helium nuclei from hydrogen. The way in which this transmutation takes place in the sun is interesting since it not only tells us what is happening in the sun today but also gives information about its past history and future life

and a good engineer. He is condemned as a radical by his enemies and praised as an advanced social planner by his admirers. He has since been appointed by President Truman to head the Atomic Energy Commission.

Other men in the group were Carroll Wilson, who was secretary of the Board and Herbert S. Marks, a government lawyer of high repute and assistant to Under Secretary of State Acheson. Though not officially members of the Board of Consultants, the latter two men, Wilson and Marks, took as much part in the two months cross-country discussions as any of the other men.

The story of how these seven men (Dean Acheson stayed home most of the time) worked together—how they talked and lived atomic energy in offices, in automobiles, in Pullman compartments, aloft in Army airplanes and in the vast atomic energy plants of the Manhattan District is a fascinating one, and one should read Daniel Long's account of it in the August 17, 1946 issue of the "New Yorker" to really understand how difficult their job was and how well they did it. Their findings subsequently formed the basis of the Baruch Report on Atomic Energy Control to the United Nations Atomic Energy Commission.

As already mentioned, Professor Oppenheimer lectured to the lay members of the group. Since the Board had to get the facts about atomic energy and not just argue over points of view, right at the beginning the non-scientific members of the Board were given an informal course in nuclear physics by Professor Oppenheimer. An old and experienced hand at the game, he tackled this job with zest and enthusiasm and discoursed long, learnedly and what is more important, patiently. "We had a blackboard in a room on the top floor of the American Trucking Associations Building in Washington" Marks relates, "And Oppie, with chalk and pointer would lecture away to us about U-235, U-238 and U-239, and something called 'denaturing' and the characteristics of this and that, and why uranium and thorium ores are the only raw materials out of which atomic products can be made."

Time after time, Oppie, as he was called by the members of the Board, would drive this fact home. "Only in the reactions of very light nuclei, and in the reactions of the very heaviest, has there ever been known, to the best of our knowledge, any large-scale release of atomic energy." He repeated this so often, the members of the Board never forgot it. "Only the heaviest nuclei" he used to say, "will maintain a chain reaction and of the elements containing the heaviest nuclei, uranium and thorium are the only ones of practical significance."

Sometimes after a lecture that was supposed to make this point abundantly clear, one of Oppenheimer's lay students would discourage the professor by asking some such question as "Since this is all a matter of turning mass into energy, why can't clay be used just as well as uranium and thorium?" The Professor would smile gamely and repeat a good part of the lecture he had just finished. Professor Oppenheimer's persistence and patience in driving this fact home was due to no mere whim or personal prejudice; it was based on a sound and intimate knowledge of nuclear physics as well as existing experimental evidence.

Since the atomic bombs were dropped on Hiroshima and Nagasaki many people have become familiar with the principle of the equivalence of mass and energy as symbolized in the Einstein equation

$$E = mc^2$$

This equation states that the amount of energy E equivalent to any mass m can be determined merely by multiplying the latter by the square of the velocity of light, c^2.

This equation is simple enough for a child to understand. It shows that one kilogram (2.2 pounds) of matter if converted into energy, would give 25 billion kilowatt hours of energy. This is equal to the total electric power generated by the electric power industry in the United States in approximately two months.

Einstein Equation Valid for All Materials

It will be noted that the Einstein equation does not take into consideration the *kind* of matter involved; it merely refers to the amount. It is reasonable to assume therefore that it is as valid, for a mass of clay or iron as it is for uranium. And this view is quite correct; theoretically, it makes no difference what kind of matter is considered, any mass, m of whatever kind of matter we may choose, represents an equivalent amount of energy, given by the Einstein equation. Practically, however, at least in the mass energy transformations which we are able to effect here on earth, we are limited to certain kinds of matter—as Dr. Oppenheimer said, to only the very heavy elements typified by uranium and thorium.

It will be noted, however, that Dr. Oppenheimer also mentioned the light elements. "Only in the reactions of *very light* nuclei and in the very heaviest has there been any large scale releases of atomic energy. In the atomic bomb, of course, we use the very heavy elements, uranium and plutonium.

What about the light elements? What are the prospects of obtaining a release of energy from them? To answer this question, it is necessary to go back into history a little. Before 1919 no one had succeeded in disturbing the stability of ordinary nuclei or affecting the disintegration rates of those that were naturally radioactive. In 1919, however, Rutherford showed that high-energy alpha particles, (i.e. helium nuclei) could cause an alteration in the nucleus of an ordinary element. Specifically he succeeded in changing a few atoms of nitrogen into atoms of oxygen by bombarding them with alpha particles. The arrangement he used was simple, as shown by Fig. 1. The process involved may be written as

$$He^4 + N^{14} \rightarrow O^{17} + H^1$$

meaning that a helium nucleus of mass number 4 (an alpha particle) striking a nitrogen nucleus of mass number 14 produces an oxygen nucleus of mass number 17 and a hydrogen nucleus of mass number 1. The hydrogen nucleus is of course a proton.

In the decade that followed Rutherford's work, many other similar experiments were performed with similar results. One series of experiments of this type led to the discovery of the neutron which plays such an important part in the physics of the atomic bomb and in the chain reaction in the production of plutonium.

For the present, however, we will forget the neutron and confine ourselves to a study of the nuclear structure of some of the lighter elements, hydrogen, helium, lithium, etc.

It should be hardly necessary to repeat here but according to our present views, the nuclei of all atoms are made up of neutrons and protons. Thus the nucleus of the hydrogen atom consists of only a single proton. The nucleus of the helium atom consists of two protons and two neutrons. The nucleus of uranium 238, consists of 90 protons and 146 neutrons. The sum of the

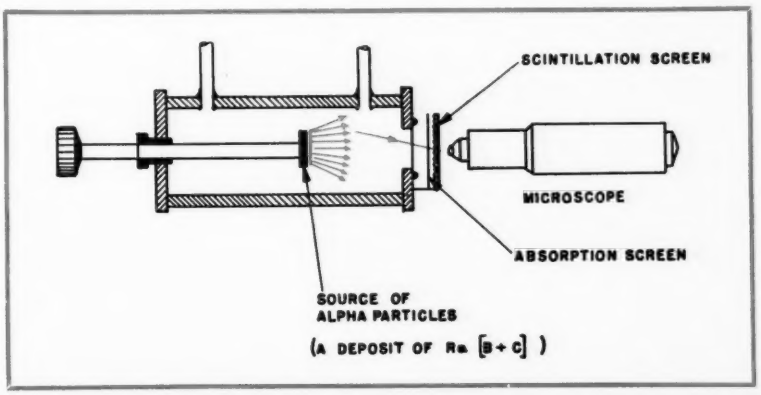


Fig. 1. This shows Rutherford's original equipment for the transmutation of nitrogen into oxygen. Alpha particles from a radium deposit bombard nuclei of nitrogen and cause the transmutation. At the same time swift moving hydrogen nuclei are set free, which traverse the thickness of the absorber and are detected on the scintilation screen

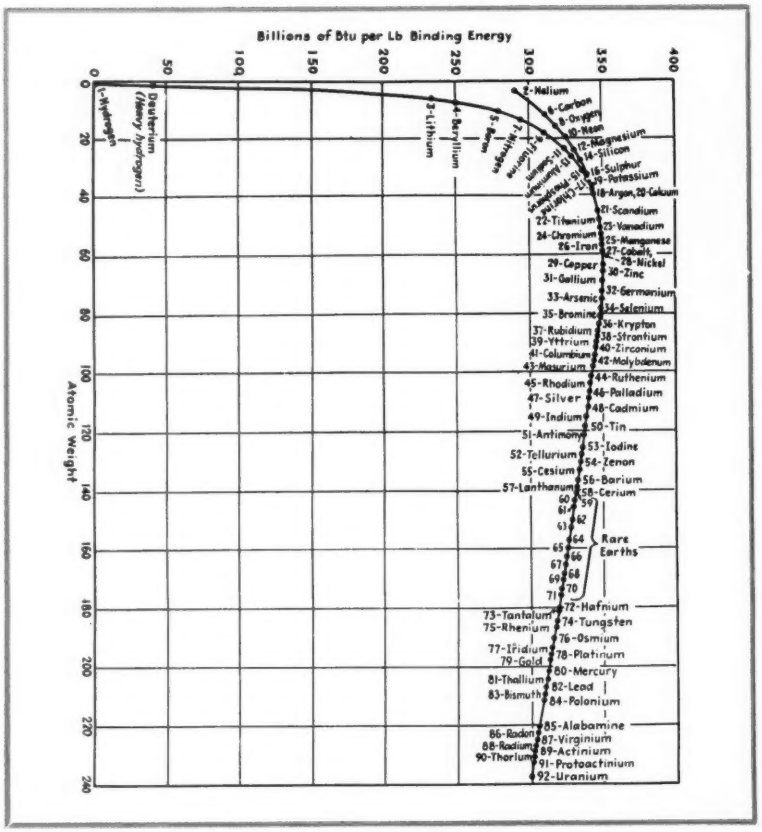


Fig. 2. Chart showing the binding energies in Btu per lb of all the natural elements plotted against their atomic weights

numbers representing the neutrons and protons is the atomic weight of the element. Thus the atomic weight of helium is 4, that of uranium 238 is 238.

Light Nuclei Reactions

The protons and neutrons in an atomic nucleus are held together by certain forces—nuclear forces. In some cases, as in the naturally radioactive elements such as radium, the arrangement of protons and neutrons is such as to make the nucleus unstable and such nuclei spontaneously fly apart. That is why we call them radioactive.

In a stable nucleus, such as helium, iron, oxygen, etc, there is no such tendency towards spontaneous disintegration, and if we should want to break up such a stable system it is a general principle of physics that work must be done on it. If an assemblage of neutrons and protons is stable energy must be supplied to separate its constituent particles. If energy and mass are really equivalent, then the total mass of a stable nucleus should be less than the total mass of the separate protons and neutrons that go to make it up. This mass difference, then, should be equivalent to the energy required to disrupt the nucleus completely, which is called the binding energy.

Consider the alpha particle, that is the helium nucleus. It is stable. It consists of two neutrons and two protons; its mass number, therefore, is four. Its atomic number is two (represented by the two protons).

Now the mass of the proton is 1.00758 and that of the neutron 1.00893. Thus the total mass of the separate components of the helium nucleus is

$$2 \times 1.00758 + 2 \times 1.00893 = 4.03302$$

Actually, however, the mass of the helium nucleus is 4.00280. Neglecting the last two decimal places we have 4.033 and 4.003, a difference of 0.030 mass units. This then, represents the "binding energy" of the protons and neutrons in the helium nucleus. It looks small, but remembering the Einstein equation $E = mc^2$, we find that it is very large. Actually 0.030 mass units is equal to 4.5×10^{-5} ergs per nucleus or 2.7×10^{19} ergs per gram molecule of helium. In units more familiar to the engineer, this means that to break up the nuclei of all the helium atoms in a gram of helium would require 1.62×10^{11} gram calories or 190,000 kilowatt-hours of electrical energy.

It is not likely that we would want to expend 190,000 kilowatt hours to break up the nuclei in a gram of helium; there would be little point to it. The Einstein equation works both ways, however. If it takes 190,000 kilowatt hours to break up a gram of helium atoms, it follows that if we could assemble a gram of helium nuclei from free neutrons and protons, this same amount of energy would be released. Evidently, it is worth exploring the possibility of getting energy by so combining protons and neutrons.

In recent years, improved mass spectrograph data supplemented by nuclear reaction data have given accurate figures for binding energies for many atomic species over the whole range of atomic masses. This binding energy B, is the difference between the true nuclear mass M, and the sum of the masses of all the protons and neutrons in the nucleus. That is,

$$B = (ZM_p + NM_n) - M$$

where M_p and M_n are the masses of the proton and neutron respectively, Z is the number of protons, $N = A - Z$ is the number of neutrons, and M is the true mass of the nucleus.

If the binding energies of all the nuclei of the various elements are examined it will be found that the general trend of the binding energy *per particle* is to increase rapidly to a flat maximum around $A = 60$ (nickel) and then decrease gradually again. Evidently, the nuclei in the middle of the periodic table—nuclei of mass numbers 40 to 100—are the most strongly bound. Any nuclear reaction where the particles in the resultant nuclei are more strongly bound than the particles in the initial nuclei will release energy. The binding energy in Btu per lb of all the material elements is shown in Fig. 2.

Thus, in general, energy may be gained by combining light nuclei to form heavier ones or by breaking very heavy ones into two or three smaller fragments. In the case of uranium, we break a very heavy nucleus into smaller fragments, such as boron and krypton. The binding energies of both boron and krypton are greater than that of uranium, therefore, the "fission" process is accompanied by the release of a great amount of energy.

From the evidence given by the atomic bomb, we know that the fission of uranium does give us energy. Uranium, however, is relatively scarce and it would seem that if we could work at the other end of the periodic table and build up heavier nuclei from the very light ones it would be to our advantage. Suppose we could produce helium from hydrogen by simply combining four protons to form an alpha particle. As already indicated, the Einstein equation shows us that this process would give us some 190,000 kilowatt hours of energy per gram molecule of helium.

The mathematics is simple. What stops us, then, from doing this? There is plenty of hydrogen in the world. Many other similar reactions are possible. In the laboratory we have been able to produce helium by bombarding lithium with hydrogen. In 1932 J. D. Cockcroft and E. T. S. Walton in Rutherford's Laboratory bombarded a target of lithium with protons of 700 kilovolts energy and found that alpha particles were ejected from the target as the result of the bombardment. The nuclear reaction which occurred can be written symbolically as

$$_3Li^7 + {}_1H^1 \rightarrow {}_2He^4 + {}_2He^4$$

Without showing the entire calculation,[1] it can be stated that as a result of this reaction there is a loss of mass equal to 0.0185 mass units which appears as 17 million electron volts of energy.

Well, if these figures are correct, why have atomic plants not sprung up all over the world. After all, if we can get 2.76×10^{-5} ergs from an atom of lithium struck by a proton, we might expect to obtain approximately a half million kilowatt hours by combining a gram of hydrogen with seven grams of lithium. It certainly looks better than burning coal.

As might be expected, the thing is not as simple as it seems. The difficulties are in producing the high speed protons and in controlling the energy produced. All the experiments done in this direction have been units of very small quantities of material, large enough in number of atoms to be sure, but in terms of ordinary masses, infinitesmal—not in tons or pounds or grams, but in fractions of micrograms. The amounts of energy used up in the experiments has always been far greater than the amount generated by the nuclear reaction.

The release of nuclear energy is not unlike the release of energy in a chemical reaction such as combustion in that it takes a certain amount of energy to start the process. A piece of wood will not burn until it is heated. In the same way, to bring two light nuclei together requires a certain amount of initial force. They can be brought very close but then their mutual electric repulsive force comes into play and this prevents their combination. The kinetic energy which two nuclei must have in order to come together in the process of a head-on collision is equal to the product of their charges divided by their combined radius. Since the radii vary slightly from nucleus to nucleus, the main factor is given by the product of the electric charges, so that the "activation energies" increase very rapidly along the periodic system of elements. For a carbon hydrogen collision the charge factor is $6 \times 1 = 6$, for nitrogen-helium $7 \times 2 = 14$ and for a collision between two oxygen nuclei $8 \times 8 = 64$.

In considering the heavy elements—those at the other end of the periodic table, the term "activation energy" refers to the energy which must be communicated to a metastable[2] nucleus in order to produce the critical deformation leading to fission.

Now that we understand something of what is meant by binding energy, and knowing that by means of cyclotrons and such devices we can impart sufficient energy to particles to cause nuclear transformations with consequent liberation of binding energies, it is natural to ask, why, in a given quantity of matter, when one such transformation takes place, does not the process communicate itself to the surrounding nuclei and a chain of reaction follow? The answer to this question is rather involved since it depends on several factors, but it can best be explained in terms of probability—probability of a head-on collision between two nuclear particles. This, it can be shown, is an extremely remote possibility, first because of the excessive smallness of the particles as compared with the size of the atom and the space between the atoms. An atom it must be recalled consists of a nucleus surrounded by a system of electrons—a sort of electronic envelope. These electronic envelopes are very large compared to the nucleus. As a matter of fact the area of the nucleus—the so-called target area—is some hundred million times smaller than the target area of the surrounding envelope. This gives the stray projectile which enters the atom only one chance in hundred millions to hit the nucleus. Also, when the charged projectile passes through the diffused atomic envelopes of countless atoms in its path, it loses energy due to electric interaction with the electron forming the envelopes. It is thus slowed down and put out of action. This is shown in Fig. 3.

It should be obvious, therefore, that ordinary charged projectiles like protons, alpha particles, etc., used in bombarding experiments will lose practically all of their energy after passing through a few hundred thousand atomic systems. This may seem like a lot of atoms but, remember, the chance of hitting the nucleus is about one in several hundred millions, so there will be only one projectile in several thousands which will collide with a nucleus before it is hopelessly slowed down.

In any bombardment process, therefore, most of the projectiles will be lost and even the few that do hit nuclei do not necessarily effect a breaking up of the latter. Even though the lucky hits may release great amounts of energy of the projectile, the energy of thousands of other projectiles will be hopelessly lost.

It is for this reason that bombarding experiments with cyclotrons and other types of accelerators, useful as they may be in producing token disintegrations of various nuclei, cannot result in any practical release of nuclear energy. Even if the output of cyclotrons was enormously increased, the losses sustained would not make possible a continuous chain reaction.

Thermonuclear Reactions

What is needed is some process whereby large numbers of nuclei can be disintegrated at the same time. One way of doing this would be to impart high speed motion to them, not by accelerating them electrically but by heating a mixture of the target and projectile materials to a very high temperature. This is the method whereby ordinary chemical combustion is sustained. When we heat a piece of coal or wood what we actually do is impart greater motion to the molecules and atom of the material. In the same way, if we could heat the target-projectile mixture to a high enough degree, the thermal velocity of the particles would be high enough to effect the disintegration desired.

Unfortunately, to produce sufficiently high velocities in our particles, it would be necessary to attain a temperature of hundreds of thousands or even millions of degrees.

It is quite possible to calculate the temperature that would be necessary to release certain amounts of energy in the case of specific nuclear reactions. Suppose we take one of the simplest and also the best from the standpoint of low activation energy, the reaction between two deuterons. The deuteron, it will be recalled, is the nucleus of the heavy isotope of hydrogen; it consists of a proton and a neutron. By directing a beam of deutrons from a cyclotron against a target of heavy water which, of course, is also composed of deutrons, it is possible to produce light helium and neutrons. The reaction can be expressed as follows:

$$_1D^2 + {}_1D^2 \rightarrow {}_2He^3 + {}_0n^1$$

This reaction is accompanied by the release of 3.2 million electron volts of energy. As shown by Gamow,[3] by sub-

[1] For a more detailed analysis of this reaction, see "Applied Nuclear Physics" by Pollard and Davidson, Jr. Page 71. John Wiley & Sons, Inc.

[2] Metastability is the name given to the property of any system loaded with energy which will be set free only after a certain small payment of energy is made from outside. Coal and oil for example are said to be metastable since the energy these substances contain can be released by the addition of a small amount of energy from the outside. Water, on the other hand is said to be stable rather than metastable since no energy can be obtained from the water molecule by any rearrangement of its atoms.

[3] Atomic Energy in Cosmic and Human Life. The Macmillan Co.

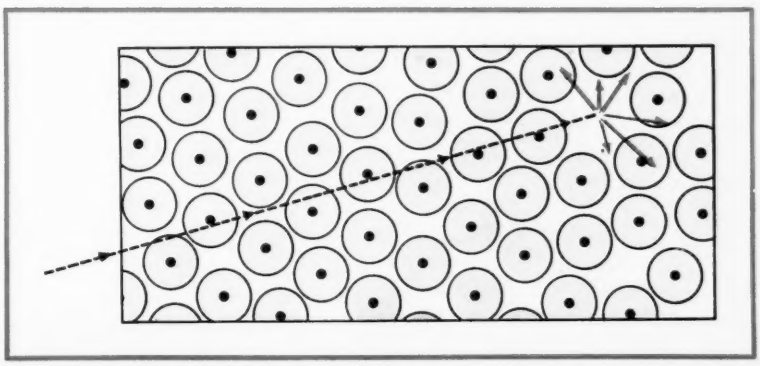


Fig. 3. This drawing shows how the energy of a fast moving particle is absorbed in passing through the electronic shells of atoms in its path

XUM

stituting the numerical data pertaining to this reaction into the theoretical formula for *thermonuclear* reactions it is possible to calculate the rates of atomic energy production that can be expected at different temperatures.

Figure 4 shows the results of such calculations expressed in graphic form. In this graph, the rate of energy generation is plotted against the absolute temperature. This curve shows that no energy is liberated at temperatures below 400,000 deg. Even at that temperature, a gram of deuterium liberates only 0.001 calories per second. At this rate it would take a whole day to produce enough energy to boil an equal quantity of water. Even at 800,000 degrees, the energy liberation is only 100 calories per second (about 400 watts). At 1,200,000 degrees, however, the energy liberation is 1,000,000 calories per second or about 4000 kilowatts. At this rate, the gram of deuterium would be used up in 6 hours. At 2,000,000 degrees, the energy liberation would be at the rate of 1 billion calories per second and here we would come dangerously close to the explosive point where all the available energy would be released practically instantaneously.

Now, it becomes evident, why we cannot very well harness the energy resulting from the nuclear reactions of these light nuclei. No furnace that we could build now or in the future could maintain the high temperatures needed to sustain these reactions. If we could build a furnace capable of withstanding a temperature of a million or more degrees, the thermonuclear reaction in deuterium could supply us with almost unlimited power. But no material can withstand such enormous temperatures. Even such a high heat resisting material as tungsten evaporates at less than 6000 deg. Any type of furnace we might build to contain the reaction would turn to gas long before the required temperature was reached.

It is interesting to consider the possibility of producing a high enough temperature (something on the order of 2 million degrees, say) to explosively release all the energy in a gram of deuterium, though here the chances of success are not much greater. There might be a possibility of obtaining such high temperatures by sending a very powerful electric discharge through a thin wire. Here again, the chances are that the amount of energy required to produce the temperature would be greater than the amount of energy released but the situation is not hopeless. Perhaps by utilizing the high temperatures and pressures evolved by uranium fission a light atom nuclear reaction could be attained. Indeed, it appears that in the development of the atomic bomb considerable work was done on the possibility of producing a hydrogen-helium type bomb. Such a bomb would have perhaps a thousand times the energy of the present bombs.

For power generation, however, the prospects of obtaining nuclear energy from the intersection of the light nuclei are not very good, and that we will have to confine our attention to the atoms at the top of the periodic table, for sources of nuclear energy. Here we can make use of a neutron induced chain reaction.

The impossibility of obtaining energy from the interaction of the light atoms it will be seen does not invalidate the Einstein equation, $E = mc^2$. The Einstein equation is perfectly valid for all elements; the difficulties lie in our inability to set up the conditions under which the desired reactions could take place.

Stellar Nuclear Reactions

The fact that we cannot produce these conditions does not mean that they cannot or do not exist somewhere else. They do, as a matter of fact, exist in the sun and in the stars, and it is by virtue of nuclear reactions of this type that the energy output of the sun and stars is maintained. The sun and the stars are just such great furnaces as are required—furnaces with enormously thick gaseous walls, held together by tremendous gravitational forces. Inside of these furnaces the alchemic fires have been burning for countless generations, continually producing the energy which is radiated into space.

A great deal of study has been made of the possible nuclear reactions which obtain in the sun and the stars. Some of these studies are intensely interesting since they lead to a knowledge not only of present conditions of the stars but also their history and future. From our knowledge of thermonuclear reactions and from data on the temperatures at the interior of the sun and stars, it is possible to determine quite accurately what types of nuclear reaction are taking place in these bodies.

The central temperature of our sun for example comes out around 20 million degrees C and the pressure (due to gravity) some 160 billion atmospheres. Thus, it is quite obvious that the sun's heat is not maintained by the thermonuclear reaction in deuterium considered in previous paragraphs. It was shown that this reaction would be explosive at temperatures of only around 2 million degrees. If there was any deuterium in the solar furnace it would be consumed in a fraction of a second. Whatever the reaction is, it goes on at a relatively low rate, otherwise it could not account for the long life of the sun.

It is possible to make a list of various alchemical reactions between the light elements which might be considered as being responsible for stellar energy production and to show the time needed for each reaction to run halfway under conditions existing in the stellar interiors. Such a list is shown in the accompanying tabulation. This was compiled by Gamow on calculations made by H. Bethe.

The mean reaction times for various alchemical transformations under the conditions of the interior of the sun. (Temperature 20,000,000 deg C)

Alchemic Reaction	Mean Reaction Time
$_3Li^7 + {}_2H^1 \rightarrow 2{}_2He^4$	1 min
$_4Be^9 + {}_1H^1 \rightarrow {}_3Li^6 + {}_2He^4$	15 days
$_5B^{11} + {}_1H^1 \rightarrow 3{}_2He^4$	3 days
$_6C^{12} + {}_1H^1 \rightarrow {}_7N^{13}$	2.5×10^6 years
$_7N^{14} + {}_1H^1 \rightarrow {}_8O^{15}$	5×10^7 years
$_8O^{16} + {}_1H^1 \rightarrow {}_9F^{17}$	10^{12} years
$_{17}CL^{37} + {}_1H^1 \rightarrow {}_{18}A^{38}$	2.10^{25} years
$_2He^4 + {}_2He^4 \rightarrow {}_4Be^8$	1.10^{15} years
$_3Li^7 + {}_2He^4 \rightarrow {}_5B^{11}$	3.10^{13} years
$_6C^{12} + {}_2He^4 \rightarrow {}_8O^{16}$	2.10^{21} years

It is evident from a study of this tabulation that such reactions as that between lithium and hydrogen are entirely too fast. If any lithium, for example, had been present in the interior of the sun it would have been completely used up in a violent explosion in the very first days of its existence. On the other hand, some other reactions such as the one involving oxygen-hydrogen, chlorene-hydrogen are too slow—they would not liberate energy fast enough to maintain the heat of the sun.

So we look to a reaction, somewhere in between and we find that the only alchemic transformations which can be responsible for stellar energy production are the reactions between carbon or nitrogen on one side and hydrogen on the other.

This particular reaction has been

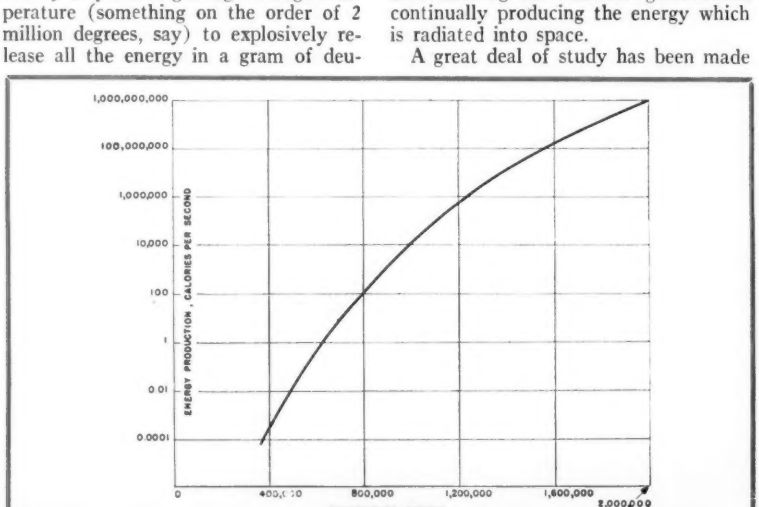


Fig. 4. This curve shows the thermonuclear energy release in terms of absolute temperature

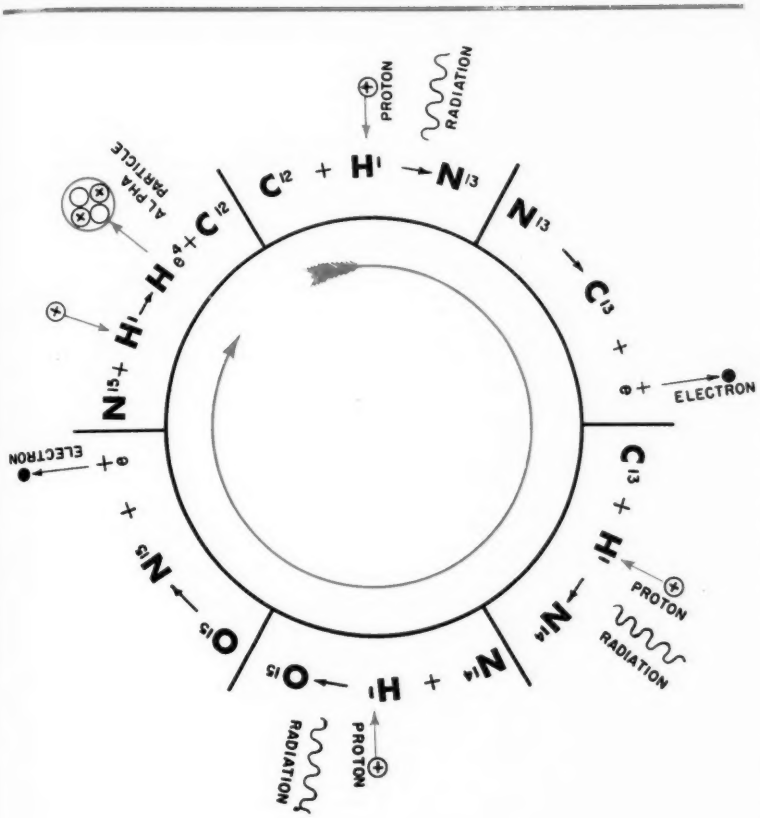


Fig. 5. Here is how helium is built up from hydrogen nuclei in the sun and also in many other stars. This is the Carbon-nitrogen cycle according to Bethe and Wiezsaker. The carbon and nitrogen which enter into an alchemic reaction with hydrogen do not vanish but are regenerated again and serve as a sort of a catalyst

given a great deal of study and its exact nature was discovered independently by H. Bethe in America and C. V. Weizsächen in Germany. The interesting point in their discovery lies in the fact that the nuclei of carbon and nitrogen which enter into an alchemic reaction with hydrogen do not vanish, but are regenerated again through a very peculiar process known as the carbon-nitrogen-cycle. The carbon and nitrogen act as a sort of catalyst to effect the transformation of four protons into a helium nucleus.

The Carbon-Nitrogen Cycle

The process is depicted in Fig. 5. As shown by the tabulation previously referred to, when a carbon nucleus fuses with a hydrogen nucleus, it produces the nitrogen isotope with atomic weight 13. It is possible to perform this union in the laboratory by bombarding a carbon target with a stream of fast protons. The nitrogen (13) nucleus thus formed is unstable and by emitting a positive electron transforms itself into a nucleus of stable but rare isotope of carbon, $_6C^{13}$. The mean time for this transformation is about ten minutes.

These stable heavy carbon isotope nuclei exist until they are again hit by another proton. The capture of this proton, increases both the weight and the charge of the nucleus by one unit, thus converting it into a nucleus of ordinary nitrogen with atomic weight 14.

In time this nitrogen nucleus captures a third proton, turning it into a nucleus of oxygen 15. Oxygen 15, however, is again unstable and in two minutes it becomes a nucleus of stable nitrogen 15 by the emission of another positive electron. Since nitrogen 15 is stable these nuclei move around through the interior of the star until, once again, they encounter a proton.

Now an interesting thing happens, and this can be proved by laboratory experiment. If the fourth proton were captured by the nitrogen 15 nucleus as its three predecessors were, the result would be the nucleus of oxygen 16, that is ordinary oxygen. The energy liberated in the capture of the fourth proton, however, sets the compound nucleus of oxygen 16 in such a state of agitation that it immediately breaks up into two unequal parts. The small part is a helium nucleus and the remaining part is the nucleus of ordinary carbon with *which the cycle began!*

Thus, it is seen that four protons captured successively by a carbon nucleus (with two of the protons turning immediately into neutrons), are re-emitted again at the end of the cycle in the combined form of an alpha particle. This is a most remarkable reaction and it is well worth anyones study. As pointed out so well by Gamow, the carbon-nucleus itself comes out of the reaction unchanged, like the Phoenix from the ashes, and its role consists only in helping, or catalyzing the transformation of hydrogen with helium.

Probably it is possible to built a helium nucleus out of four protons without this catalyzing influence, but to do that the four protons would have to meet together at some point in space, and considering the disorder of thermal agitation, the probability of such a quadrupal collision is exceedingly remote. The catalyzing nucleus catches all the protons one after the other and holds them until all four are collected, and we have here, according to a witty remark of Atkinson and Houtermans, a nuclear pot in which helium is cooked from pure hydrogen.

ATOMIC PILE'S FOURTH ANNIVERSARY

On December second the nuclear physicists in U.S.A. and abroad foregathered to celebrate the fourth anniversary of letting loose nuclear fission, which was accomplished in Chicago under the auspices of the University of Chicago. Summarizing what this meant in a few words of plain English, both as to language and weights and measures, Professor Dee, a British scientist has told us that burning a pound of coal liberates energy equivalent to 5.6 horsepower-hours, but the fission of 1 lb of uranium liberates 30 million horsepower-hours.

On Dec. 2, the Archbishop of York, speaking at Bradford, England, envisioned a war in which 40 million persons might be killed in the first few hours of fighting. Dr. Arthur H. Compton, who is in the top-drawer of scientists, and was an observer of the historic event in Chicago, Dec. 2, 1946, said in Paris that he believed that the odds favored considerably the view that major wars among the great powers are already a thing of the past; and he foresaw that atomic power might become a serious competitor with the coal industry in U.S.A. about 1955. Dr. Walter Zinn told a gathering of 1000 colleagues at Chicago that the harnessing of atomic energy would cost tens of billions of dollars and is "still some time away." Dr. Enrico Fermi, who was the principal actor at Chicago, Dec. 2, 1942, said that the atomic energy machines at the Argonne Laboratory have already proved to be valuable tools, which have changed the course of some branches of chemistry, physics and biology. Dr. F. E. Johnson in a ceermony at Hanford Engineer Works in the State of Washington, declared that 5000 workers are still occupied there.

THE OUTLOOK FOR FREEDOM

(*Continued from Page 67*)

increases supplies in relation to demand. Only by increasing productivity can we raise *real* wages.

2) Both individuals and businesses should refrain from making deferable expenditures for the time being.

3) We should all support vigorously the Treasury Department's campaign to sell series E and F bonds of small denominations.

4) Governments—national, state and local—should quickly reduce expenditures and defer projects not urgently needed at the moment. All should maintain tax rates at a level sufficient to yield revenues well in excess of expenditures in the fiscal year ending June 30, 1947.

If we can push such measures successfully, we need have no fear of inflation obtaining a stranglehold in America. They will, I am confident, take us safely through the dangerous period which confronts us.

A third and last worry I want to share with you concerns the belief on the part of so many people that another major depression is inevitable.

I am simply proposing that we would be well advised to vigorously challenge the notion that we should sit idly by and await the coming of a disastrous business collapse. After all, both booms and busts stem from the activities of men and, therefore, are in a manner of speaking made by men; and as men we can and should deny that our American economy is foredoomed to this boom-bust cycle.

I hardly need point out the dangers with which we would be beset if we should be afflicted with another major depression with its millions of unemployed. It would be a heyday for panacea peddlers. Measure after measure would be proposed—many of which, if enacted, would so vitiate our capitalistic system that it could not function. If you agree that we want to preserve our present system, then I am sure you will agree that we should take action NOW aimed at the avoidance of another great depression.

Before we attempt to lay out a detailed program with that aim, I believe we should take a long hard look at our economic system and try to find out what causes the fluctuations in the level of business. Free economics, largely in consequence of their freedom, are subject to powerful influences that induce instability in business activity primarily through affecting market demand. Market demand for goods and services is, of course, made up of the combined demands of individual customers—consumers, business firms, and the government. At a given time market demand depends upon (1) how much cash or credit is available to customers, businessmen and the government, and (2) how much of that cash or the proceeds of that credit they are willing to spend for goods or invest in business assets.

Instability in market demand results from a complex set of factors. Among these factors are: High standards of living; the large capital investments required for modern business; the credit system; the tax system; and the influence of foreign trade.

These major forces of instability operate in our free economics through the decisions of millions of consumers and many thousands of businessmen. It all nets down to this—that before we can have adequate market demand there must be both the power to purchase and the willingness to spend on the part of individual businessmen. If we consider measures aimed at the maintenance of economic stability we must give due weight to the necessity of confidence on the part of businessmen in the prospects of a profit.

Now I should like to suggest the specific areas in which Government should take prompt action to promote greater stability in our economy:

1) Our tax system must be revised to help counteract both inflation and deflation. This should not be too difficult. As a basic principle of tax policy, our tax rates should be set to balance the budget in a period of normal prosperity and then let alone. In a year of high prosperity (such as the present fiscal year) a substantial surplus of receipts over expenditures should be produced. In a year of low business activity, there would be a deficit. On the basis of our past economic history, we might have every right to expect that in any normal cycle of years conditions would average out at something better than normal prosperity.

2) Federal and local governments can help stabilize the economy through better timing of public works. In the past we have had the greatest volume of public works during times of prosperity and the lowest volume during depressions. It ought to be the other way around.

3) Our government should expand and consolidate unemployment compensation coverage. So far, we have made only limited use of unemployment compensation insurance as a social tool, but its effectiveness has been dramatically demonstrated. It gives to people the confidence in continuity of income which is so essential to the achievement of greater stability in our economy. It also makes a tangible contribution through the maintenance of purchasing power.

Now as to the responsibilities of businessmen for making our economy more stable:

1) The greatest contribution any business man can make toward stability is to operate his business profitably.

2) Every employer should regularize employment in his business to the greatest possible extent.

3) and last! Businessmen should exercise scientific control of sales expenditures. In the past American concerns have kept their sales and advertising budgets high when business was good and easy to get. Sometimes some of these expenditures were questionable. When business was slow, and sales tough to get, sales and advertising were pared to a minimum. This is neither good business nor good sense. If we are to have stabilized market demand, selling pressures should be maintained—perhaps increased—at the first sign of a decline in business. We must avoid spending sprees when business is good, so that reserves will be available when extra pressure is needed. I know of no single way business managers can do more to help stabilize market demand than through greater stabilization of sales and advertising expenditures.

Perhaps I have said enough to make clear the magnitude of the task that lies ahead and the need for all of us to engage in "successful worrying." I am sure you will agree that the stakes we are fighting for are tremendous. Assuming that through our efforts we should succeed in reducing the intensity of future fluctuations by two-thirds, let us see what it would mean. Between 1929 and 1932 the reduction in national income was more than 50 per cent. A similar reduction in national income today would mean a drop from $150,000,000,000 to $75,000,000,000. Does any one doubt that such a loss would put our system in the greatest hazard? On the other hand, if we succeeded, through the application of proper measures in reducing the intensity of future fluctuations by two-thirds, it would mean that the maximum drop in national income from present levels would be less than $25,000,000,000. I believe we could take a drop of that extent without serious repercussions. Does anyone doubt that here and now we should be putting forth our best effort to achieve a reduction in intensity? Does anyone doubt that if we are successful the outlook for freedom will be definitely brightened?

In closing let me say that it is my firm conviction that we have more than a fighting chance to achieve our goal. Perhaps mine is the voice of an optimist but I sincerely believe that during the next 25 years, the progress we will make will be without parallel. If we remain at peace the real income of most of our people can be doubled. We can also largely realize the age-old dream of abolishing poverty. Most important of all, on this material foundation we can build conditions which will provide not only equality of opportunity but certainty of opportunity for every man, woman and child to grow and develop intellectually and spiritually. Therein, it seems to me, will lie the strength, the power, and the grandeur of the America of tomorrow.

HARDLY SUITABLE for a "bubble dancer," nevertheless, the world's largest plastic bubble is a triumph of plastic manufacturing. It measures eleven feet in diameter and four and one-half feet deep and cost $10,000 to produce. Made of transparent Plexiglass, it will house a rural three dimensional scene in a giant advertising sign in Detroit.

The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

WANTED, JOB IN SUPER POWER STATION

The letter presented under this same title on page 98 of this issue came to us from one of our subscribers in far-away India. He is a graduate engineer from the Benares Hindu University with twelve years of practical experience in the design, erection and maintenance of small and medium size industrial power plants. So, he knows something about power plant engineering. Now, however, because of his faith in post-war development of Indian Industry, he is desirous of learning, by actual practical experience something about our larger generating stations—he calls them super power generating stations. What he means, of course, is our regular utility type of plant, our medium and large central stations.

We are presenting his letter exactly as he wrote it. Considering that this man is a Hindu, it is an excellent English letter and he asks intelligent questions. We hope that someone who reads this may be in a position to help this man. He might be quite an interesting person to be associated with for a while and in return for the knowledge he may acquire here he might be able to teach you the Hindu rope trick.

As far as his coming to the United States is concerned the British Consul here in Chicago assures us that there would be no trouble. All that would be necessary would be for him to establish the fact that he would be self supporting while in this country. There have been a considerable number of foreign students and engineers, many of them Chinese, working in industrial plants and power stations in this country under similar arrangements during the last few years.

As his letter shows, aside from the fact that he wants to come over here, he also is desirous of establishing correspondence with American engineers. We feel sure that any of you who may write him will find such correspondence profitable. You can address him as follows: P. K. Nag, Chief Engineer, Pulgaon Cotton Mills, Ltd., Pulgaon (C.P.) India.

Here is a chance for you to help someone and at the same time broaden your own horizons.

A.W.K.

CONTENTS

Commercial Tying of Knots **88**
By H. B. McDermid

The Making of a Stationary Engineer **90**
By Earl Pagett

Practical Hints and Kinks **93**
Drilling Shaft
Gear Puller
Tightening Hollow Set Screws
Spacer
Portable Work Bench
Keeping Desks Where They Belong
Electric Fan Repair

How Electrical Machines Function—Part II **94**
By R. Andriessen

The "Other Fellow" Has the Accidents **97**
By John G. Reynolds

Letters and Comments **98**
Wanted, Job in Super Power Station
How to Prevent Power Plant Casualties
Still Running After 43 Years
Leaves for the Book
Engineers Gold Mine

Questions and Answers **100**
What Should He Do About This Excess Exhaust Steam?
Does He Need to Get Rid of the Bottleneck?
What Should Be Done About This Old Plant?
Would Enclosure Improve Oil Cooler?
Why Doesn't This Chimney Produce Enough Draft?
Where Should Relief Valves Be Installed on Economizers?
How Tell Whether Coal or Oil is Cheaper to Burn?
Why Do His Automatic Stop Valves Chatter?
Why Does He Have to Roll Tubes Oftener?
Can He Use the Earth to Reduce Temperature of Cooling Water

Bus Bar Weights Chart **104**

A Section of Power Plant Engineering Devoted to
PLANT OPERATION AND MAINTENANCE

Technical Publishing Company
53 West Jackson Blvd., Chicago 4, Ill.

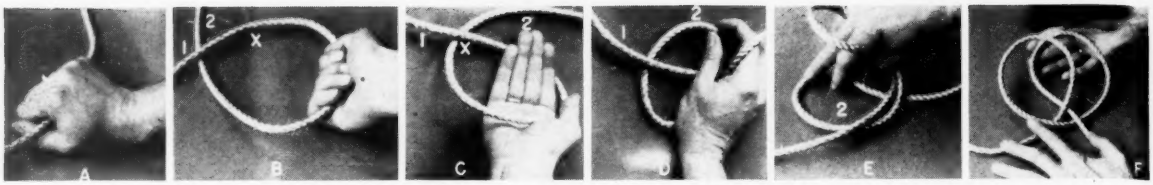


Fig. 1. A shows manner of holding rope when picking up from floor or table to tie clove hitch. B, the rope has been flipped over in a clockwise twist. C, the hand is slid through the loop with the back of the fingertips resting on part X. D, running end 2 is picked up between the thumb and forefinger. E, then a clockwise twist and a flip of the wrist throws a second loop in the rope. F, finished knot

Commercial Tying of Knots

Speed and more speed is required in riggers' operations including knot tying . . . Life, limb and a foreman's prestige often hang on speed and safety of knots and knot tying . . . When to use what knots, knots to avoid . . . Step-by-step tying is graphically shown

By H. B. McDERMID

Fig. 4. This is a finished sheepshank. Its most practical use is to shorten an unnecessarily long rope

IN A RECENT article in POWER PLANT ENGINEERING the writer mentioned the rapid tying of knots as applied to the use of gin poles. Not only is this valuable to the job from the rigger's angle, it is also very important from the foreman's side, too. The ancient definition of a king used to be "the man who can," which very definitely applies also to the foreman who desires to hold the respect of his gang. If he can, on occasion, jump in and tie good knots so fast that it makes them all look silly, he has gone a long way toward making them respect him—which he must do somehow if he is to long remain a real leader.

So, at the risk of somebody yelling "Boy Scout!" here goes for the description of how to tie a few knots at high commercial speed. No attempt will be made to teach a sailor anything about handling knots and lines in his work, for he knows that better than most landlubbers; he uses that knowledge all the time, must know it to survive in many places and so knows it thoroughly.

There are knots galore which can be used in a rope; but for the average rigger only a comparatively few are genuinely useful, if care is taken to use the proper knot in its right place. Of prime importance to the rigger is the requirement that his knots shall be safe—his own life and that of his mates often depends on his rope skill. Poor or unsafe knots simply cannot be tolerated, and lack of knowledge or carelessness can often make a man a potential killer, many times inadvertently. So, safety is of first rank in requirements. This is really brought home to a novice the first time he ever gets placed where

Fig. 3. This is the weavers' knot. Its outstanding characteristic is that it will lie flat

nothing but his own good muscles and his rope skills are responsible for the continuance of his life and the probable rock pile is too far down to even hazard a guess as to how far he would fall if his knots should fail.

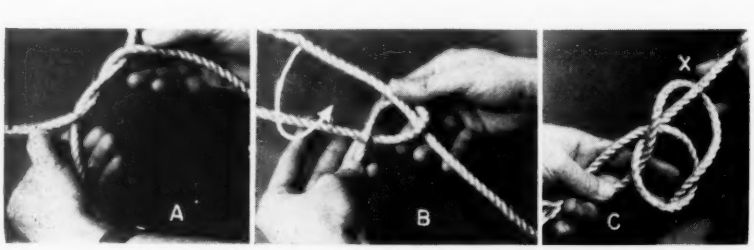


Fig. 2. An overhand knot is quickly tied in the rope as shown at A. By rolling the overhand knot you then get an arrangement as shown in B; the arrow shows the direction in which the running end will now go. The finished, untightened bowline knot is shown in C

Next to safety is commercial speed both in tying a knot and in knowing that it can be easily and quickly opened. A worker may know a safe, proper knot —but of a half dozen ways to tie it, does he know the fastest way—can he tie it on the run, not even looking at his line and know it is right? Usually his mates do know a few knots that well and if he is to compete he must learn too. Generally he really needs but a few knots if properly applied each in its proper place.

One of the good common knots is the clove hitch which can be applied to pull in either direction, either singly or on both strands leading from it, at once. It can be picked off the floor with one hand only, quicker than the eye can follow, and the trick is not too generally known. Usually riggers are chary of disclosing the tricks they know, but the accompanying photos show how this safe knot can be handled at high speed.

This method is of course applicable only where the knot is to be slipped over an object like the end of a gin pole where the rope is to be used similarly to a guy line. Pick up the bight of the rope in your right hand, palm downward as in Fig. 1A; you may leave it lying on the floor, or draw it across the left palm for support only, it does not matter. Now turn the right hand palm up, holding the rope loosely; this causes the parts 1 and 2 to cross, as in Fig. 1B; now push the hand forward till the backs of the finger tips rest on Part X, and as you turn the hand back palm downward, hold part X in position, and swing the elbow out till the hand stands 90 degrees to the right with the original position at start, with the fingertips now resting on Part 2; pick up Part 2, twist it clockwise and your clove can actually be picked up like a flash, with a little practice, after the detailed

moves are mastered, and any man who won't find a bit of rope and practice in his spare time, is not going far in the rigging business.

In places where an end is not available the clove must be tied in a slower manner, but the knot and its action are the same. If interested, get a piece of light cord and practice this rapid method till you can't do it wrong, and it will be yours for life. Rope work, half learned, can be forgotten quicker than almost anything there is, so start in slowly, master each move till you are sure you know it and then it will, with occasional practice, stay with you for good. So much for the clove hitch.

The ordinary bowline can be tied very quickly also. It is valuable because it is easily opened after moderate strain. The loop, however, will cut the standing line under it every time if the strain be heavy, so if you figure you are to have a destructive strain, it is best to choose some other knot. One fast way to tie it goes like this: Grasp the end of the rope in the right hand, and using both hands, tie an ordinary "thumb knot" as shown in Fig. 2A. Next, throw a loop in the standing line by rolling the thumb knot over and it will appear as shown in Fig. 2B. Now pass the end of your line under the standing line and around to the left, and back DOWN through the loop as in Fig. 2C and the bowline is complete. It can be tied very quickly by this method and while both hands are required, one does not even need to see the rope while tying it by this method. The knot is usually easily released by rolling part X up the standing line in the direction of the arrow.

Another good knot that opens easily is sometimes called the weaver's knot, Fig. 3, and is said to be used by that trade because it lies so flat when pulled tight. It holds perfectly and after strain opens nicely.

The sheepshank, Fig. 4, is a knot that is not used as often as its worth would indicate, but is highly valuable in its proper application. I have known of its use in pulling a heavy machine to its place where hauling room was often restricted, and the boss and all hands were paid by piecework rates. The hauling rope could be shortened by two men in the matter of seconds, and the man who introduced the stunt to that gang was quite popular.

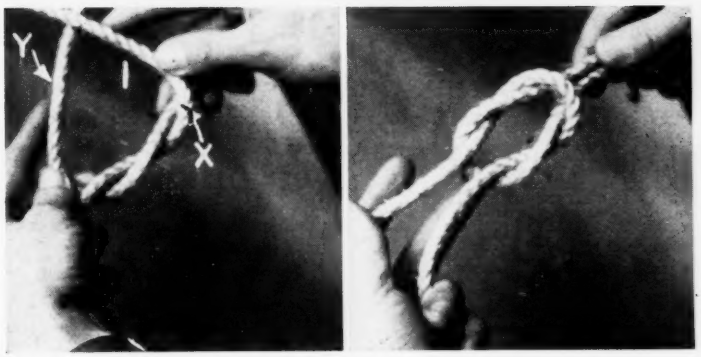


Fig. 8. This shows the start and completion of the square knot. Note that line 1 crosses the line X on the same side as it does the line Y. If this precaution is followed the end product will always be a square knot and never a granny or false square knot. See Fig. 9

Editor's Note: Fig. 5 shows a fairly fast method of making the sheepshank. Three loops are laid one over the other in the manner shown in the photographs. By reaching through the top of the last-formed loop and under the first loop to be formed and grasping the middle loop, you may then pull these two sides of the middle loop through outside loops. This method works well only on small rope and when both ends or at least one end of the rope is free or when there is sufficient slack in the rope to allow the three loops to be quickly formed.

Another quickly placed hitch is the Blackwall hitch, used on a hook. It is safe, and can be put on with speed. It is shown in Fig. 6. Simply wind one turn of the line clockwise over the bottom of the hook, leaving the long part at the back leading off to the left, while the short end, nearest the operator, leads off to the right. Now loosen the turn well and slide it back, around the shank of the hook, as shown clearly in the sketch. The load line now pinches across the short part and locks it on the hook and the heavier the strain, the tighter the pinch. It is plenty safe if kept tight, loosens at once when the strain is released. I should recommend that it be lashed in place to the hook, if used where the strain is intermittent. Again the sketch is self-explanatory.

The "stopper hitch" is another that is very valuable in its place. If a line is stretched partially between two supports, and it is wished to tighten it more, the stopper is used to attach another line to it and pull up the slack in the direction the line is stretched. Properly attached, the hitch does not slip, and is easily released. It is easiest to use when the second line is somewhat smaller than the line to which it is attached, so that the pulling line can

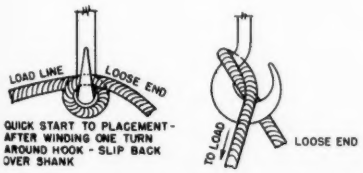


Fig. 6. The Blackwall hitch is safe, easily put in place and easily detached. The heavier the load the tighter this knot will grip. One turn of the line is wound clockwise over the bottom of the hook leaving the load end at the left and the free end at the right. (See text)

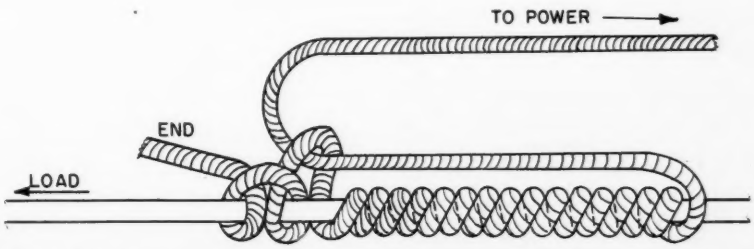


Fig. 7. This sketch shows the stopper hitch. It is used to pull lengthwise on an existing, partially tightened line or cable. The pulling line should be smaller than the line or cable to which it is attached

Fig. 5. Here are five steps in making a sheepshank in a fairly rapid fashion. Note that all loops are thrown in the same manner. See text for complete instructions

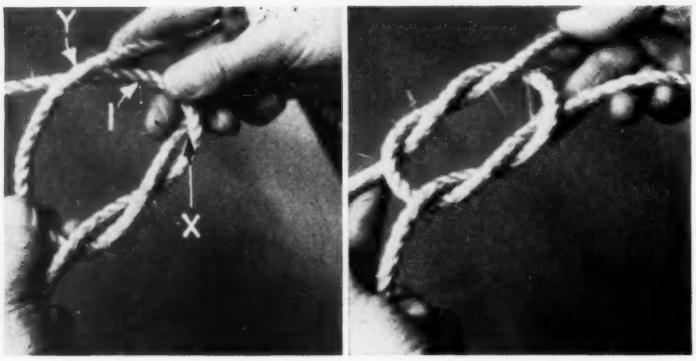


Fig. 9. Here is the Granny knot. Note that line 1 crosses line X on the near side but that it crosses line Y on the far side. This will invariably result in the undesirable granny knot

wrap securely around the line to be tightened. (See Fig. 7).

The "becket hitch" is another very handy knot used on the becket of one of a pair of rope blocks. It is simply a clove hitch tied with the short end of the line, around itself, after passing through the becket. Its virtue lies in the fact that it will pull up very flat thus permitting the two blocks to come very close together when pulled "two blocks," as the rigger calls that situation. It aids the job when you need all your head room. (No sketch is made of this one).

The common two half hitches will hold the maximum power of the line it is used in, but in such a job, needs an axe to open it. For that reason, should only be used in light to medium strains.

Be sure to learn the square knot, Fig. 8, as it is easy to confuse with the granny knot, Fig. 9, which is sure to slip and is highly dangerous. The granny will hold on pack thread, but with rope, is no good. On high work or on heavy pulls, it is deadly. Don't use it. The photos show clearly the difference in the two knots. Learn them thoroughly, for not to know them can easily be fatal. The square knot is safe in most places, but cannot be readily opened.

Fig. 10. For clarity, this timber hitch is shown out of its natural environment, i.e., around a log, timber, beam, etc.

The timber hitch is another valuable knot and widely used, as it will hold well, is easily applied, and as easily opened. See Fig. 10.

Much good can be accomplished by the proper use of hitches, totally aside from the knots used in them. For instance, several turns of rope may be used around a hook and its load, with only one part having a knot in it. It is a good plan to have one part go around the load only so that part can bind the load tight in the hitch. Always let the knot be in that unhooked part, so that the knot, aided by the friction between the rope and the load, will not pull up so tight that it is hard to open.

If the knot is placed in a part that gets the direct pull, perhaps all the pull, it will be hard or commercially impossible to loosen.

But don't waste time on fancy knots —perhaps a dozen are really useful and will take care of most situations as they arise. But learn them thoroughly and they will then be always at your command, ready to handle most of your rigging jobs as they come along. If any unusual needs arise, the well trained rigger can usually come up with an answer, even if it does require the learning of some new stunts.

The Making of a Stationary Engineer

This personal history of the author is more than an account of one man's experience; it is an account of the development of steam engineering in this country. It should be of interest, not only to the old timers whose experience parallels that of the author but also to younger men who may find in it information of value in mapping their own careers

By EARL PAGETT

THE SUBJECT on which I am about to write should be of interest to all who are or have been stationary engineers. Having followed the profession for many years, I feel qualified to speak "as one having authority." I dislike the personal pronoun, but my story is from personal experience and observation—hence it seems best to write in the first person.

Just before and at the turn of the century, there were few towns in which a steam engine and boiler plant of some description could not be found. Even out in the country, there were many steam tractors, for powering threshing machines, portable rock crushers, sawmills, etc. One of my uncles had one of the first threshing "outfits" in our community, and it was the wonder of my young life.

In the small towns would usually be found, one or more grain elevators, a flour mill, a sawmill and a creamery, especially in the agricultural communities, with an added cotton gin in the southern cotton sections. In mining sections were steam hoisting engines and steam driven crushers, and in oil territory, steam engine driven drilling and pumping machinery.

In larger towns, in addition to the flour and sawmills, there might be a planing mill or two, an "artificial" ice plant, a water pumping and storage plant called the "water works," maybe a shoe factory, and in the south, cotton mills and tobacco processing plants.

Small cities could boast of several manufacturing industries and possibly an electric light plant, larger cities would have many industries. All machines were driven from the flywheel of the steam engine, through a series of belts or ropes, shafts and counter shafts, although the main line shaft was sometimes flanged or "clutched" directly to the engine crank shaft.

All there plants provided many jobs for stationary engineers. Most of the boilers were of the return tubular type and working pressures rarely exceeded 100 psi. Most engines were of the plain D slide valve type, in the smaller sizes, but in the larger plants, the "Corliss" four valve type predominated and was considered the acme of perfection.

While the smaller plants were comparatively simple at this period, they did require a certain degree of knowledge and not everyone wanted to try to run them, for even a small boiler could, and sometimes *did* blow up.

However, these same plants made a place where the "engine minded" youth could get a start and the necessary experience, which coupled with the technical knowledge absorbed from books which even then were obtainable, made it possible for him to step up into a more complicated plant, if and when opportunity came.

Types of Plants

In my early experience, I have memories of a "fire-box" type boiler and an engine mounted on skids, pulling a saw mill. The fuel was green slabs and equally green saw dust.

The owner of the outfit was the sawyer and the harder he crowded the saw, the more money be made and incidentally the more exhausted I was when night came.

Another memory is of a 100-hp return tubular boiler generating steam for an inertia-governed, variable cut off, slide valve engine, pulling a "wood products" manufacturing plant.

This boiler was also green slab and sawdust fired. Have you tried this kind of fuel? It is no snap as I remember it. There was a special boiler front with two large fire doors at grate level, through which the slabs were fired, and a smaller door, high on each side, through which the sawdust was shoveled and piled high, the higher the better.

I remember also a nice little 20-hp boiler and a 16-hp slide valve throttling governor engine in a planing mill. The fuel was shavings and mill refuse, supplemented with coal as necessary, but the load was light and I had time to study a complete steam engineering course for which I had enrolled. The time was well spent as I was to find later when it came time for me to go before the board for State license examination.

This habit formed at this time has borne fruit a number of times, as will be seen as the narrative proceeds.

Before passing on, I might say that there was a planer knife grinder in the same basement with the power plant—also a wood turning lathe and I did not miss the chance to get some grinding and turning experience (which was not required of me) but I have found that it did not pay to pass up any opportunity to gain knowledge and experience.

These smaller plants usually ran during the day only and the engineer would of necessity have to get to the plant and raise steam before starting time, which made a good long day, as such plants usually ran ten hours per day.

The Hours Were Long and the Pay Small

One flour mill ran 12 hours per day and this meant I had to leave home around 5:00 a.m.

In plants which ran "around the clock," the day engineer, would start at 6:00 a.m. and be relieved by the night engineer at 6:00 p.m.

The pay was not large but quite a bit better than common labor and the work more stable and decidedly more interesting, as there was always something that could be learned.

In the medium or large size cities there were usually enough engineers to have a local branch of their organization usually the NASE (NAPE at this time). The licensing of stationary engineers as required by law in many states provided an incentive for self education and there were even classes in Stationary Engineering in some of the larger cities presided over by competent engineers.

The distribution of power was the one factor limiting the size of steam plants. Few now can realize the miles and miles of leather belting used in these early plants. The machines had to be located as close to the engine as possible and even then there was a large loss in power due to the friction from the point of generation to the actual application.

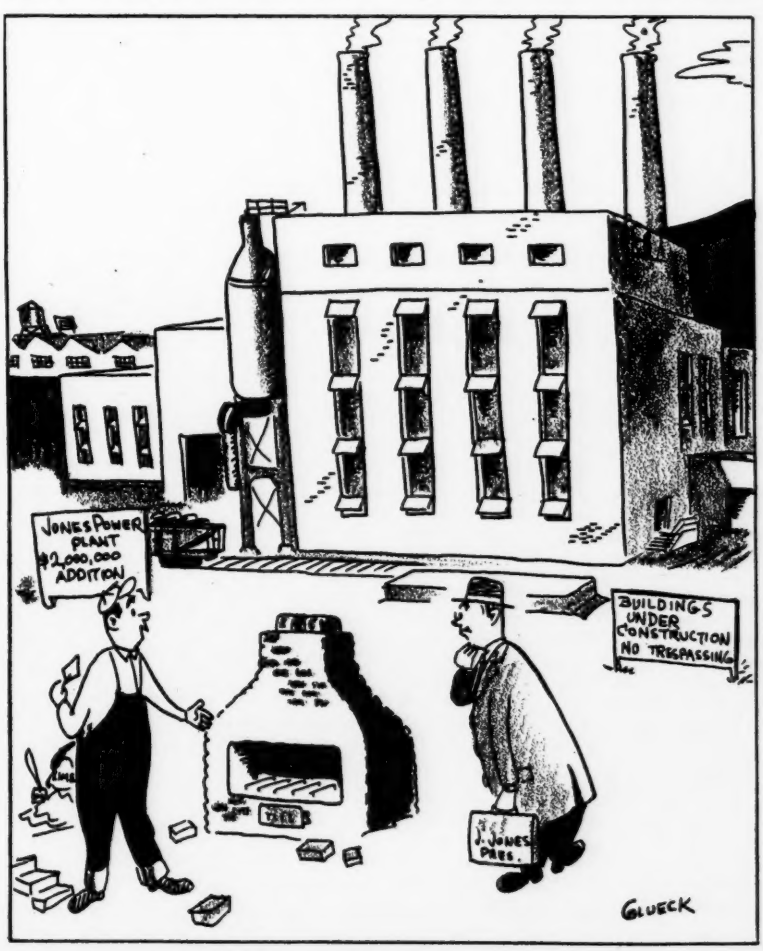
With the twelve hour shift, an engineer did not have much time off duty for society (even if he had the energy) but he knew responsibility and was proud to feel that he was a good substantial citizen and of some importance in his neighborhood and among his fellow engineers.

Gradually many improvements made their way into the steam plants —steam pressures kept creeping higher — the water-tube boiler was coming into general use—many engineers owned indicators as a means of studying steam distribution in the cylinder—flue gas analysis—mechanical stokers—compounding cylinders —improved condensers and water softeners were introduced to take away the bane of an engineer's existence, boiler scale.

The crank and connecting rod had long served its purpose in converting a straight line motion into turning motion but the steam turbine was being developed for getting the circular motion directly without either the crank or connecting rod. Other things too numerous to mention here but important enough to keep an engineer on his toes and "burning the midnight oil" came into the picture.

Came the Central Station

As I said before, in most of the small cities "there was an electric



"Well, there were some bricks left over——"

light plant"—and it was just that, but with the development of the simple a-c induction motor, the electric light companies conceived the idea that they could hook on a motor here and there, run their plants continuously and get some increased revenue.

This idea eventually put the "skids" under many stationary engineers. One by one the small manufacturing plants went to electric motor drive and shut down their steam plants. The Electric Light companies become electric light and power companies, selling both light and power and every motor installed made less opportunity for the stationary engineer.

Some few steam driven plants survived and the engineers stayed but the lives of countless engineers were disrupted and they had to branch out into what kindred work that they could find.

Some of the larger companies put in up-to-date generating plants of their own and changed to motor drive. This saved some engineers and prodded them into making themselves competent to handle the new plants or get out.

Personally I was able to get a position with the local Light and Power Company and was safe (temporarily, as this plant was subsequently absorbed by a larger company). Here, instead of the slide-valve engines and fire-tube boilers, I got my first chance at water tube boilers, a 400-hp, 4 valve (Gridiron type) and a double eccentric Corliss four valve engine.

These engines were belted to alternating-current generators. They were up-to-date and economical but I always went home from my 12 hour shift tired out, for it was a "one man" job and I not only had to "watch" the plant but hand-fire the boilers as well.

Coal was the fuel and we were allowed 150 psi which was high for that time.

I have often wondered if I made a mistake (I might have been absorbed into the large company with my plant or I might have been "dropped") but I could not resist the offer of a position as engineer and assistant electrician with a substantial industry which was making its power, in a city across the state from where I lived.

At this plant I had the rare opportunity to observe the operation of one of the early Westinghouse - Parsons Steam turbines directly connected to an a-c generator, although I did not get to operate it as my duties were mostly electrical at this plant. I did get some turbine experience later.

After 3 months, I was transferred to one of my company's new plants in a distant state. When we were through installing the electrical machinery and distributing system (d-c, 240-volt motors and lighting) I was put on the 12 midnight till 8 a.m. shift in the power house, and this was the first time that I had ever worked an 8 hour shift.

We had new fire-tube boilers, new simple Corliss engines and direct current generators and switchboard. My shoveling days also were over as the boilers were gas-fired. This was a "far cry" from the old hand-fired plants. This plant was in natural gas territory, and some gas engines were being installed in the vicinity.

Being curious, I wanted to see what made a gas engine "tick" so obtained a good textbook and as my work was easy, I had plenty of time to find out and again my effort was not wasted.

Within two years a panic hit the country, my plant was shut down and I was laid off indefinitely. Then came an appointment as Superintendent of the Municipal Electric Light and Power Plant in the same city but being more engineer and electrician than politician, I soon tired of it and resigned.

I Get a Gas-Engine Job

Times were hard and good jobs scarce but the engineer in the only gas engine plant in the city quit his job. Most steam engineers were prejudiced against the gas engine and so I got a chance at it.

Due to the fact that I had laid aside my prejudice and became interested enough to study the theory and mechanism of the gas engine as compared to the steam engine, I was able to make good. This company was a growing concern and added machinery continually required more power.

During my stay several more gas engines were installed and at one time I had 8 scattered around the place and belted to grouped machinery. They ranged up to 165 hp and as they were not all of the same make and some of two and some of four stroke cycle, I had a varied experience and at the end of my stay I had a fairly good reputation as a gas engineer.

One of the main engines was housed in the machine shop and I had also absorbed some machine shop practice between trips of inspection around to my scattered charges.

I could possibly have stayed in this plant until the present time (the central station could never take it over and it was still running when I last heard about it) but ambition drove me "to tackle" the chief engineer's job in a large gas engine — electric central station, which was offered.

Many times I wished that I had not been so ambitious, but I did not back down. The plant had two 550-hp and two 750-hp horizontal tandem, double acting gas engines with "built on" alternators and was in poor condition to say the least.

I had a heartrending job trying to keep three of these units in parallel on the load and overhaul the fourth one. By keeping the unit down that needed repairing the most, the plant was gradually built up to a point where it showed stability and efficiency. I obtained a gas consumption under 20 cu ft per kw-hr.

My jobs before had been mostly one man jobs but here I learned what it means to direct and handle other men and had to hire and fire as I found necessary; however, it was seldom that I was compelled to let a man go.

I will not tire you with details but since that time I was chief in another station of the same type, a master mechanic in a zinc smelter (the first one to roast ore and smelt zinc with pulverized coal—now defunct)—master mechanic in a clay products plant, a machinist, and other things too numerous to mention.

In summing up I find that I have had well over a dozen positions—not counting these where I worked more than one time for the same company. Out of that number, only three plants are still going and only one of the three (the Municipal Electric Light and Power Plant) is a steam plant; a reciprocating steam engine plant originally but a turbo-generator plant now. Not one of the reciprocating steam engines that I ran is still in the running.

To the best of my knowledge, two of the gas engine plants are still running which speaks well of this type of power. They have competed successfully with the central stations all these years.

In conclusion, I have endeavored to show by my own experience the changes that have been wrought in power generation in one short lifetime and the changes that one must make in his own life to adapt himself to these changes.

Little did I think when I started that the pace would be so fast and that it would require so much effort to keep up with the trend and foresee the next jump to get a little ahead of it.

Some engineers have "stayed put" on the jobs that they had when the central station took over. A few may still be running the same engines, but usually they have been compelled to tear out old machines and put in more modern ones, possibly many times. They also had to struggle continually to keep up with advancement, else the central station would have absorbed their plants.

The modern steam central station with pressures far beyond what I could imagine when I started and total temperatures of 900 deg would seem to be near the limit, but who can tell. Besides, atomic power may upset our whole power system as completely as did the central station and I for one am not going to miss any opportunity to learn all I can about this new force.

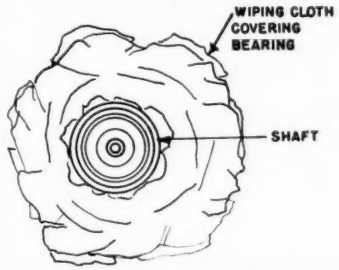
No LONGER is it necessary to count sheep to enter the slumber state. The latest method is to put on your record player, the album known as the Recorded Sleep Inducer. It is reported that a guarantee is issued with each set and testimonials claim good results.

PRACTICAL HINTS AND KINKS

DRILLING SHAFT

By Thomas Trail

RECENTLY it was necessary to drill holes in an axle very near the ball bearings that supported the axle. In order to prevent metal dust and chips finding their way into the bearings a simple expedient was adopted. As shown in

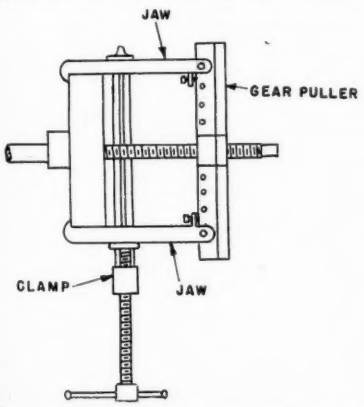


Showing how metal dust was kept out of bearings

the sketch, a hole was punched in a suitable piece of wiping cloth and the cloth shoved over the shaft and used to cover the bearing completely. This provided an effective seal for the bearing.

GEAR PULLER

IF THE jaws on a gear puller tend to spread and slip off the object being pulled, use an ordinary steel screw

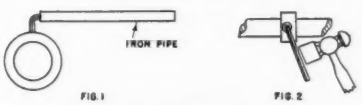


Showing how the jaws of gear puller can be kept in place

clamp to compress the puller jaws and hold them in place, as shown in the accompanying figure.

TIGHTENING HOLLOW SET SCREWS

WHEN TIGHTENING hollow set screws be careful not to apply too much force to the wrench or it may break. A handy tool to use consists simply of a short length of small diameter iron pipe. This should be slipped over the wrench handle as far as possible so that spring in the wrench will be eliminated.

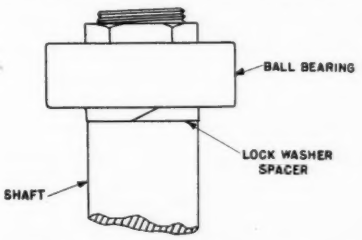


Showing method of tightening hollow set screws

If a length of pipe or tubing is not at hand and hammer blows are used to tighten the screw, avoid striking the wrench at either end since this may damage it so that it will no longer fit the set screw socket. Furthermore, only light hammer blows should be used to avoid breaking the hardened wrench.

WASHER AS SPACER

A LOCKWASHER that has had its temper drawn by heating makes a handy emergency spacer for machine parts.

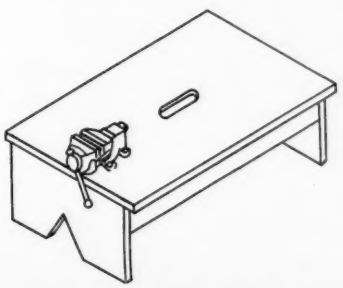


Showing how lock washer can be used as spacer

PORTABLE WORK BENCH

By Thomas Trail

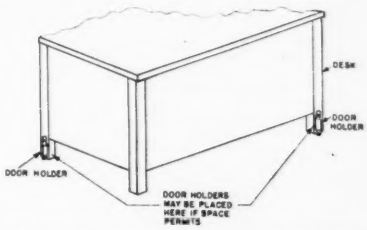
A SMALL wooden bench on which is mounted a small machinist's vise is very handy to carry around to various jobs such as working on door locks and hinges, etc. The bench may be used to stand upon in order to reach the top hinge on a door or it may be used to sit upon when working on the lock. The attached vise is handy when lock keepers or other parts require filing. Also handy when hanging doors.



Design of portable work bench

KEEPING DESKS WHERE THEY BELONG

A PAIR OF ORDINARY friction door holders, attached to diagonal legs of a desk, as shown, will prevent the desk



Showing how door holders can be used to keep desks in place

from sliding on smooth hard floors, such as cement, tile or marble. Whenever it is desired to move the desk the holders may be released from the floor by a touch of the toe.

ELECTRIC FAN REPAIR

By Thomas Trail

SOMETIMES THE blades of an electric fan will become bent and this will cause vibration when the fan is operated, due to the unbalanced condition of the blades.

It usually is a difficult job to repair such damaged blades so as to restore them to perfect running order. Therefore, it is generally advisable to purchase a new set of blades from the dealer.

Since repair parts are sometimes difficult to obtain now it may be necessary to repair damaged fan blades as well as possible. If the blades are bent or twisted out of uniform circumferential line, as shown in Fig. 1, they should be reshaped as nearly as possible to a uniform position. This can best be done by placing a small guide on the fan guard to gauge the correct position of each blade in succession. A piece of wire will be satisfactory for this purpose.

If the blades are bent as shown in

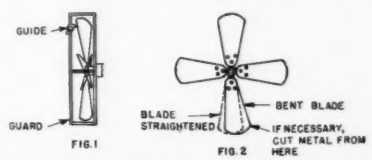


Fig. 1. Showing how small guide can be placed on fan guard. Fig. 2. If necessary a small section can be cut from the fan blade

Fig. 2, they should be straightened to as nearly a uniform, even spacing as possible.

But if the fan still vibrates considerably after this remedy has been tried it may be necessary to cut a small section from the bent fan blade in order to lighten it and thus restore it to balance.

If a fan is permitted to vibrate excessively it is likely to wear out the shaft bearing. For this reason such fans should not be operated.

How Electrical Machines Function Part II

This is the second part of a three part article by Mr. Andriessen . . . In Part I presented in the January issue he discussed the elementary principles underlying motor and generator design and operation . . . Here, in Part II he considers direct-current motors and generators . . . He shows how the basic principles discussed in Part I are applied in the design of motors and generators and shows the difference between the various types of direct-current machines. Part III to be presented in a future issue will cover alternating-current machines

By R. ANDRIESSEN

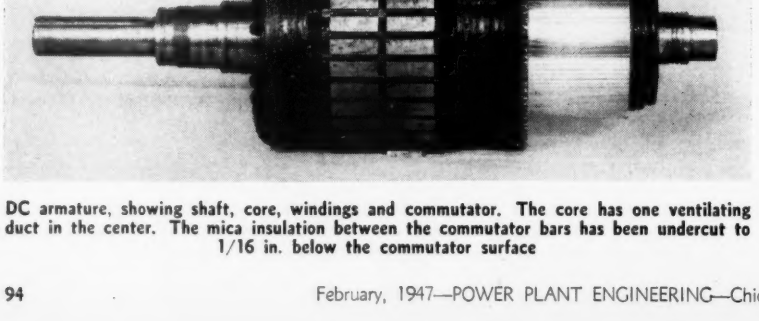
Electrical Engineer, Crocker-Wheeler Electric Manufacturing Co.

THE D-C MOTOR is a device by which the electrical energy, as it is applied over the wiring system, is changed into mechanical energy which is available at the shaft projection and which is used to drive various kinds of machines.

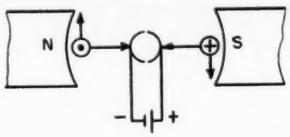
Fundamentally it consists of a magnetic field and a rotating element which contains coils and a device for reversing the direction of the current in the coils. The first part consists of the frame, the poles and the field coils around the poles. When a current flows through the coils, the poles become magnetic. The coils are wound in such a way that one pole will be a "north" pole, the next one a "south" pole, and so on.. The rotating part, the armature, consists of coils embedded in a core and a commutator which reverses the current. The brushes work together with the commutator to accomplish this. Brushes are actually nothing but devices to make and maintain electrical contact with a rotating element.

Figure 6 illustrates the principle. The poles N and S produce a magnetic field and the two sides of a loop of wire are located in that field. Both sides carry current, one in a direction away from the observer, and one in the opposite direction. The two vertical lines marked + and — represent a source of current, for instance, a storage battery. In accordance with Fig. 4, forces will act on the sides of the coils, one being upward, the other downward.

These coils are located in slots in the core and the core in turn is fastened to the shaft, so that these two forces will produce a twisting moment, that is torque, and will try to rotate the shaft. When the shaft has turned one-fourth revolution or 90 deg, the sides of the coil will then be located vertically above each other and the forces will no longer tend to produce a torque but will act in the same vertical plane. Suppose that the inertia should carry the wires past this vertical plane. Then the forces acting on the sides will attempt to return the coil to the vertical plane, if the currents in the respective sides of the coil still flow in he directions indicated on the drawing. But if the current could be reversed at the instant that the coil passes this vertical plane, then the forces would also be reversed and torque would again be produced in the same direction of rotation. The two semicircles in the center of Fig. 6 make it possible to reverse this current. They rotate together with the wires of the coil while the brushes supply them with current from the storage battery. These



DC armature, showing shaft, core, windings and commutator. The core has one ventilating duct in the center. The mica insulation between the commutator bars has been undercut to 1/16 in. below the commutator surface



• CURRENT COMING TOWARD OBSERVER.
+ CURRENT GOING AWAY FROM OBSERVER.

Fig. 6. Diagram showing the basic principle of the d-c motor

two segments constitute the fundamental principle of a commutator. In other words, the commutator serves the purpose of reversing the current that flows through the coils at periodic intervals. In a motor there are of course not just one set of wires or one coil but there are several such coils all acting in the same way; and there are not just two segments as shown, but there are a corresponding number of commutator bars all insulated from each other by means of mica. The illustration further shows that the current in the coils must be reversed at a point half way between the poles.

In this illustration there is one north pole and one south pole. However, it is just as well possible to use four poles or more as long as they are alternately

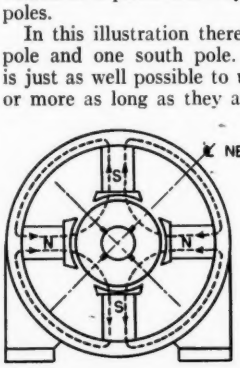


Fig. 7. General arrangement of the magnetic structure of a d-c machine

north and south poles. As stated, the coils or loops of wire are located in the armature core which serves a double purpose. In the first place it provides the coils with something on which to exert their turning force and in the second place it constitutes a part of the magnetic path, since the iron core has much less resistance to the lines of force than air has.

Figure 7 shows a schematic cross section through a 4-pole motor. The paths of the magnetic lines are shown, as well as the positions where the current in the armature coils must be reversed. These points are known as the neutral positions, and must be determined by test. The brush assembly is made movable for the purpose of making adjustments. This is accomplished by means of the rocker ring. Close adjustment is necessary to prevent freedom from sparking between the brushes and the commutator.

It is necessary for the operation of the motor that a magnetic field shall be set up between the poles, and in order to produce this field, an electric current must be sent through the coils which

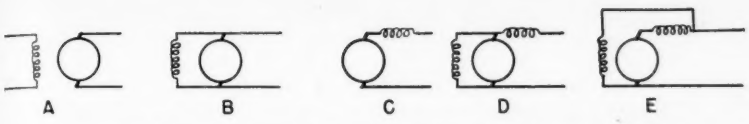


Fig. 8. Schematic diagrams of the various types of direct-current machines

surround the poles. This current may be supplied from an external source (Fig. 8a), or it may be taken from the same source which sends a current through the armature. In the latter case, the coils may parallel the armature (Fig. 8b), which results in a shunt motor, or they may be connected in series with the armature circuit (Fig. 8c) in which case the motor is called a series motor. Most general is a motor in which both a shunt winding and series winding are provided Fig. 8d and e). This is called a compound motor.

These different windings give different characteristics to the motors; particularly, they influence the manner in which the speed changes when the load varies. By a proper selection of the portions of the field produced each of the two windings (shunt and series), the desired characteristics of the motor can be obtained.

The difference between these motor types will be explained briefly. In a shunt motor, the voltage across the field is always the network voltage, so

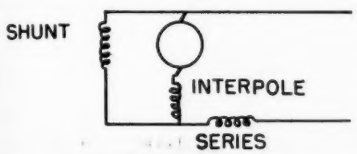


Fig. 9. Showing how the interpole is connected into the circuit of a compound wound machine

that the field strength does not change. The current which flows through the armature coils will vary with the load on the machine and this will cause slight variations in the speed (usually approximately 5 per cent between no load and full load). Since the speed is fairly constant regardless of the load, the motor is suitable for lathes and other machine tools.

In a series motor, the entire load current passes through the field coils, so that the field will become stronger when the load increases. More torque will be developed as a result. The speed of the motor will be decreased by the increase in load. The fact that the motor develops a large torque makes it suitable for cranes, street cars, elevators and other uses where the starting load is heavy.

Compound motor characteristics lie between the two. They are used where moderate changes in speed are not objectionable, while a fairly good torque is desired for starting purposes.

The interactions of the different magnetic fields cause distortions and other electrical effects which make it difficult to obtain proper commutation, that is, contact without sparking between the brushes and the commutator. Of great help in this respect is an interpole winding, which in effect is a small series winding located at one or more of the neutral positions. These coils are always connected in series with the armature (Fig. 9).

The smaller sizes of d-c motors are built with two field poles, and with either shunt coils, series coils or compound coils. For the purpose of providing better commutation, one or two interpoles may be provided.

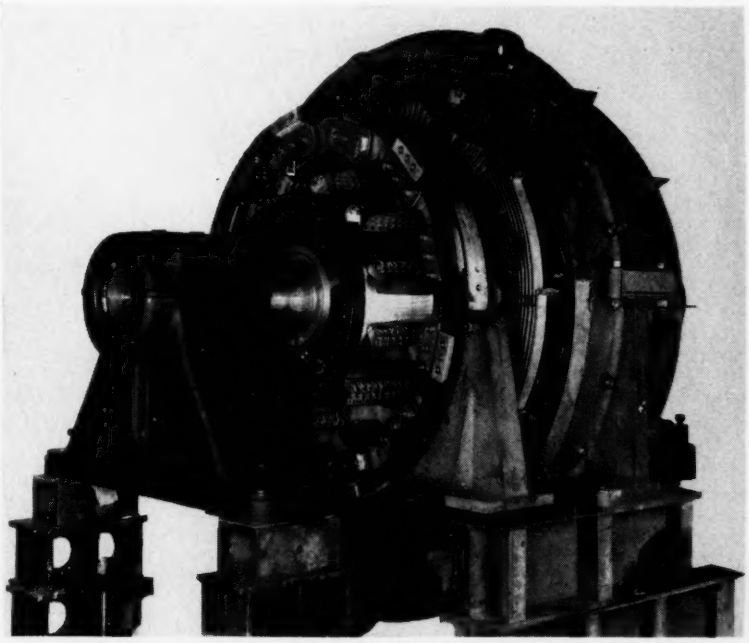
The larger sizes have a larger number of poles, and generally have the same number of interpoles. Most of these motors are compound-wound, although series and shunt motors are used for specific purposes. The smaller sizes generally have cast-steel frames and laminated poles, while larger motors are preferably built with rolled frames, either in the form of a continuous ring or consisting of two halves.

Where conditions of operation and commutation are exceedingly severe, so-called "pole-face windings" are used. They prevent flashovers, a condition in which arcs are formed on the commutator surface between the brushes on adjacent brush studs. The pole-face winding consists of copper conductors embedded in the main poles, with their ends connected together by strips. A current flows through these conductors and end connectors. This may also be called a compensating winding.

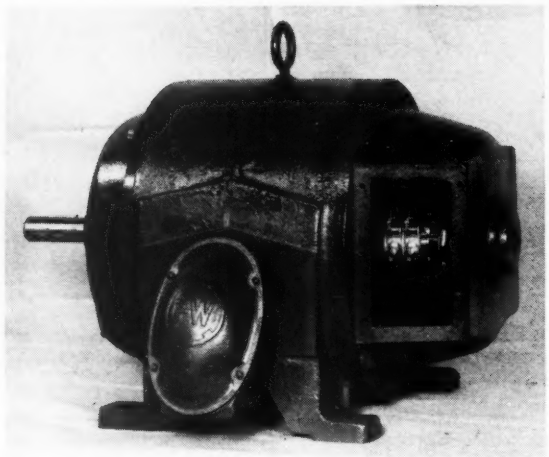
Mechanically, there are many varieties depending on the purposes for which the motors are to be used. They may be equipped with sleeve bearings as with ball or roller bearings. They may be open, drip-proof or enclosed; they can be designed for horizontal or for vertical operation; they may be provided with a ring mounting as a part of the rear bearing bracket or shield, to which a pump can be fastened, etc.

D-C Generators

Electrically speaking there is little difference between a d-c motor and a d-c generator. In a motor, electrical energy is supplied and the rotation of the shaft is the result. In a generator the shaft is rotated by means of a prime mover (steam engine, gasoline engine, etc.), and the electrical energy becomes available at the terminals. In accordance with Fig. 5, this presupposes that a magnetic field is present, through which the coils are rotated. The matter is the simplest when the field coils which produce the magnetic field are energized from an outside source (Fig. 8a); this machine would be called a separately excited generator. However, it is also possible to obtain this excitation current from the generator itself. In this way it is possible to build a shunt generator (Fig. 8b), a series generator (Fig. 8c) and a compound generator (Fig. 8d and e). This is possible for only one reason, which is that a certain small amount of magnetism remains in the poles, even after the electric current is interrupted. When the coils are rotated in this weak magnetic field, a small amount of current is in-



1750 kw d-c generator, rated 600 v, 500 rpm. The copper strips shown in front of the frame are the connections between the field coils; the U-shaped connections are a part of the pole-face windings. The commutator has 432 bars and an outside diameter of 42 in.



DC motor, rated 5 horsepower at 1750 rpm. The brush holders and commutator can be seen through the opening in the bearing bracket

duced in the armature coils and a part of this current is utilized to strengthen the field, so that more current can be induced in the armature coils, etc. In this way the field strength is gradually built up until the desired magnitude has been reached. If, as a result of unintentional reversal of the current, the poles have become completely demagnetized, then such a generator will not be able to operate until the poles are magnetized in the proper direction by an outside source of current. This is called priming the fields.

The difference between the different self-excited generators will be discussed briefly. In the shunt generator, the voltage across the field will drop somewhat when the load increases. However, this drop is small and a shunt generator will give an almost constant voltage. It is used for battery charging, and as the source of excitation of a-c generators and synchronous motors. The voltage of series generators changes more radically, since the increased load current passes through the field coils. This type is rarely used in practice. By selecting the proper combination of shunt and series fields, practically any desired relation between voltage and load can be obtained. For this reason, most generators are of this type. It is possible to alter the characteristic by reducing the current which passes through the series winding. This is done by providing a parallel path for this current, so that one part will go through the winding and other part through this "series shunt." The ratio can be varied by changing the resistance of the series shunt.

In connection with Fig. 5, it has been stated that the voltage which is induced in a coil depends on the strength of the field, and on the speed with which the number of lines that pass through this coil, changes. In the case of the motor, the forces acting on the coils will no longer produce torque when the forces act in the same plane and for this reason it is necessary to reverse the current when that condition occurs. In a generator, a voltage is induced in an armature coil when the coil passes through the position shown in Fig. 6. When this coil is rotated 90 deg, no voltage will be induced because the number of lines passing through the coils does not change at that instant. Should the coil be rotated past this point, a voltage will again be induced in the coil, but it will act in the opposite direction. The result would be that the voltage at the terminals would change in direction. For this reason it is again necessary to reverse the direction of the current when the coil passes the neutral position. This is taken care of by means of the commutator and the brush assembly, which at the same time acts as a means for collecting the current from the numerous armature coils.

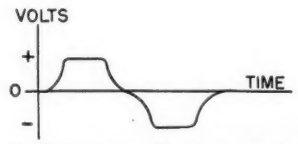


Fig. 11. Here the machine is equipped with a commutator

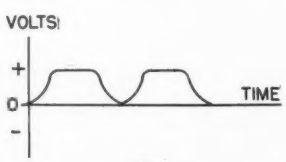


Fig. 10. Wave form of current in the armature of a machine not equipped with a commutator

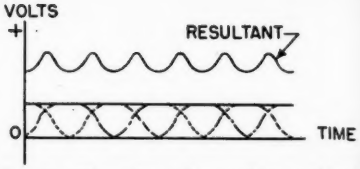
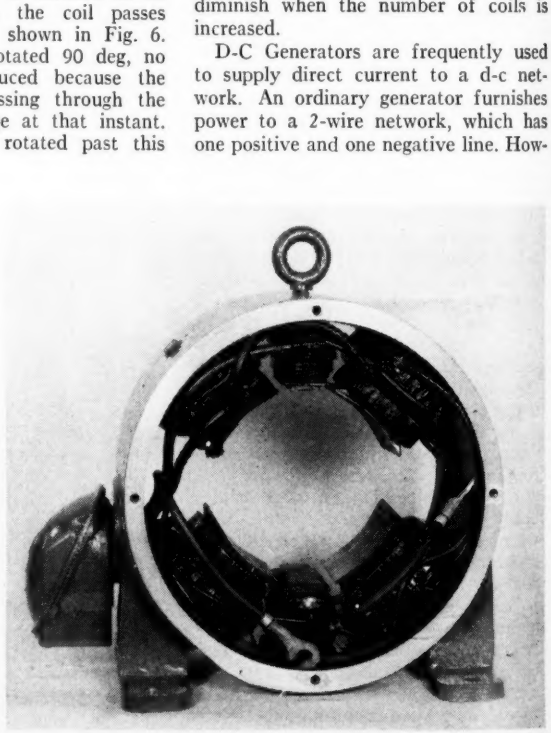


Fig. 12. Wave form of a machine equipped with a number of coils connected in series

Figure 10 shows the way in which the voltage in a coil changes as it passes through the different positions with respect to the poles. Midway between two poles the voltage will be zero and will be reversed unless there is a commutator. Figure 11 shows this same voltage when a commutator is used to reverse the polarity of the coil at the point where it passes through zero. When there are a number of coils equally distributed over the entire armature, and when these coils are all connected in a series, then the voltages which exist at any particular time in the individual coils are added together to give the resultant voltage. Figure 12 illustrates this and shows why a generator produces a direct voltage of a substantial constant value, as the ripples diminish when the number of coils is increased.

D-C Generators are frequently used to supply direct current to a d-c network. An ordinary generator furnishes power to a 2-wire network, which has one positive and one negative line. How-



DC Frame having 4 main poles with shunt and series coils and two interpoles with coils. The outside diameter of this frame is 18 in. By using different windings, this frame can be used for motors from ¾ hp at 150 rpm to 15 at 1750 rpm. The two disconnected cables will be connected to the brush rigging and supply current to armature

ever, in practice it is frequently advisable to use a 3-wire network in which the voltage between two of the wires is twice as high as that between each of these wires and the third wire that is added. For instance, many 110/220 volt networks are in existence. Electric lights and appliances are then connected to the 110-volt source, while power apparatus use the 220-volt circuit.

There are different ways in which such a network can be obtained. It can be done by using two generators, connecting two lines together to form the third wire. It is also possible to use a single generator, in which case an extra coil is connected in the circuit. This coil may be located on the armature in which case the armature will have one slip ring in addition to the commutator, the center of the coil being connected to the slip ring. This is called a generator with an internally created neutral. The coil may also be located outside the machine, in which case the armature will carry two slip rings in addition to the commutator. These slip rings are then connected to the points of the armature winding between which the coil should be placed. This is called a generator with externally created neutral and the coil is called the balance coil.

As in the case of d-c motors, pole-face windings or compensating windings are used in generators where operating conditions are extremely severe. They aid in obtaining better commutation by counteracting the distortions in the magnetic fields.

The "Other Fellow" Has the Accidents

Workers should not bask in false sunshine of the belief that accidents always happen to the other fellow. A second performance of a careless act can send any worker to the flowers and sweet music finale

By JOHN G. REYNOLDS

AFTER jogging around the country poking deep into the "whys" and "Wherefores" of today's run-away accident records, the saintly, not guilty expressions that are so often evident on the faces of those who have missed the accident brigade, plus the national tendency to believe that the other fellow always has the accidents and is causing all the damage, leads me to believe that a powerful majority of workers are barking up the wrong tree!

Let a lineman get careless while atop a 40-footer and carve a perfect hole in Mother Earth with his noggin after a sloppy jack-knife dive, and what's the reaction? . . . "Couldn't be me—that's the other fellow." Let a workman enter a manhole without thinking that gas may be lurking around ready to start an insurance check on its way to his wailing widow, and what happens? . . . "Couldn't be me—that's the other fellow." Or let a worker miss the fourth rung from the top of a 20-foot ladder and do a fast belly flop onto a clean but hard cement sidewalk, and what happens? . . . Again, it's that old story 'Couldn't be me—that's the other fellow."

To get at the true reaction after an accident has happened, any person can, by asking a few questions, suddenly discover that *it is only one person who cause the accidents.*

He is the careless guy who does everything wrong; he is careless, he goes too fast, he hogs the road, he will flip hot solder across the operating room, he thinks a safety belt's place is in the truck, he disregards goggles—he's the guy who causes all of the accidents and he's always *the other fellow.* That poor devil who cracked the brains out of his cranium in an accident today is just the poor other fellow to the fortunates who missed the same fats.

What many workers fail to realize after an accident has happened is that although today's accident happened to the other fellow, it might be their day tomorrow.

Pick up your paper tonight and read it carefully. In it you will probably find several little accident stories about the other fellow. There may be a story about a guy who followed the great American habit of dawdling at home and then hurrying on the highway to make up for lost time only to end up a grisly mess of flesh and bone that gave some undertaker a tough job. Or you may read of some poor devil who walked from behind a street car only to be flattened to a pulp beneath the wheels of a truck; or of a driver who at 80 miles per hour took the purr out of his car and stopped his own heart with an end-over-end roll that left his lifeless head wedged under the dashboard. Or possibly you may read of some luckless cableman who found out too late that the strand would not hold the weight.

You will read about plenty of other fellows during this year, next year and for many years to come. But don't let the softness of your easy chair, the homey beauty of your living room and the peaceful existence you lead, cause you to believe that the other fellow has all the accidents.

That idea of "That's him—not me," or "I'd have more sense than to do that," or "It couldn't happen to me," is a dangerous one to acquire. The mangled accident victim of today probably thought his well-padded torso was as secure from a disastrous accident as you think your own body is. Probably he once thought accidents happened only to the other fellow, but one duplication of a careless act that thousands of others previously had performed sent him into the flowers and sweet music routine years before his time.

It doesn't pay to bask in the false sunshine of the belief that accidents always happen to the other fellow. You relax on safety for one second and in that second you may rob yourself of thousands of minutes of life.

Any investigation of the factors involved in any one accident confuses anyone of its exact cause. Often a combination of factors may be present such as a weak ladder, horseplay on the job, failure to use safety equipment and failure to follow prescribed safety instructions.

But when the boys add up the lives, arms, legs, eyes, lost man hours, partial and complete disabilities, and the dollar and cents costs of accidents, two facts stand out crystal clear. One is that the victims usually have no one but them-

selves to blame, and the other is that some careless action usually is involved.

Let's take that national bugaboo—automobile accidents—for example. Of 40,000 killed in one year, 27,000, or two out of three, died because of some reckless or illegal action on the part of the driver. Maybe a slippery pavement had something to do with some of the death crashes; perhaps visibility was poor in other cases, and it might even be that the brakes didn't hold at times.

But in the final analysis all of these accidents could have been prevented if the driver at the wheel had been more cautious or law abiding and more aware of the fact that *the same careless act that killed a man today can kill another tomorrow.* It is a foregone conclusion among the experts that a good plan for any worker to remember at home, at work, or at play is that the other fellow on the slab will have plenty of neighbors tomorrow.

Accident hazards are always present just as accident reports are made out by the thousands daily. These accident reports can be the signposts of your personal safety if you study them and plan to avoid the pitfalls that got the other fellow in trouble.

It is known that on the average a person violates a safe practice 300 times before he is injured as a consequence. If you are committing some unsafe practice, you're heading for the inevitable crash; your luck will run out and then you're in for your appearance just like the other fellow—the poor guy you have often talked about but never thought you would join.

LETTERS AND COMMENTS

WANTED, JOB IN SUPER POWER STATION

The Editor
POWER PLANT ENGINEERING

Dear Sir:

With the advent of National Governmen, India has tremendous opportunity to develop her industries.

Power being the primary factor in its development, Thermal Super Power Generating Stations will play an important part in post-war planning for extensive electrification by grid system.

Your country has developed these super power stations to highest standard of efficiency and naturally I crave for further training on this branch of engineering. So, I would request you to kindly arrange by your influence to put me in contact with some Super Power Generating Station where I may work in erection and maintenance for short period and gain necessary experience to enable me to design and erect some such unit here in India.

I am a graduate in Mech. & Elec. Engineering from Benares Hindu University. For last twelve years, I am working in design, erection and maintenance of industrial power units small and medium sizes. I have special interest in up-to-date development of Thermal Power Generation with its accessories and controls and therefore subscribing "POWER PLANT ENGINEERING" through my firm.

I have enclosed two Bulletin Slips indicating paragraph numbers. These bulletins and catalogues may be collected at your Office and sent together to me, the postage of which will be paid by me. I make this suggestion apprehending the reluctance of respective firms to send these bulletins overseas.

Further, I am interested to know the present day American practice in selection of "Industrial Power Units," requiring

(i) 1000 K.W. and process steam of about 3500 lbs. per hour at 40 P.S.I.G.
(ii) 2000 K.W. and process steam about 6000 K.W. per hour at 40 P.S.I.G.
(a) Wether individual industrial units generate their own power even if bulk electricity supply is easily available from super station.
(b) Cost of Power (K.W.Hr.) when generated in own plant specifying cost of coal received on site and type of Boilers & Power Plants used.
(c) Cost of Power (K.W.Hr.) when purchased.
(d) Cost of Power Generation in K.W. Hr. in super power station specifying cost of coal received on site.

It will be great help to me if you can contact me with a few Engineer correspondence friends of industrial and super power station to exchange thoughts.

Thanking you for troubles taken,
Yours faithfully,
(Signed) P. K. NAG

My Address:—
P. K. Nag, B. Sc. (Eng.),
Chief Engineer
Pulgaon Cotton Mills, Ltd.
Pulgaon, (C. P.)
India

HOW TO PREVENT POWER PLANT CASUALTIES

IN THE October issue you published a timely article on how to prevent Power Plant Casualties. This is a very important subject and it does not always get the attention it deserves. Would like to enumerate a few instances from my own experience of recent happenings.

Part of the capital stock of any public utility is their reputation for furnishing dependable service. This means that the plant should not only be equipped with all the modern safeguards for continuous operation but that the operating force should be highly trained to vigilance in detecting minor troubles before they progress into major accidents.

For instance the ASME Code has a chapter in it on the proper routine in cutting high pressure boilers into and out of operation and all employees should be well versed on how this should be done. I refer particularly to the regulation that when a high pressure boiler is cut out of service a hold card should be placed on the steam valve connecting it to the supply mains, reading something like this—"Hands Off—Valve to remain closed—Men working in boiler." Also some operators insist on having a mechanism to lock the valve in the closed position.

As a retired boiler inspector and one conversant with these matters I was recently hired by a Casualty Insurance Company to investigate the death of an employee who was scalded to death while inside a boiler that had been off for cleaning for three days. A force of men had cleaned out the boiler and this man was now just inside the boiler replacing a gasket on the manhead preparatory to putting it back into service.

There was a sudden rush of steam into the boiler which scalded the man so badly that he died in a few hours.

On looking over the boiler I found it equipped with the usual standard safety devices. There was a standard steam gate valve next to the steam mains. Then a standard type of non-return valve between this valve and the boiler. On searching for some possible way for steam to get back into the boiler I looked over the blow-off line and found it had a separate blow off line not coupled to the blow off lines to any other boilers. The feed lines to boiler were found in good condition and no likelihood of their being blamed for furnishing a flow of steam. The man who was scalded cried out "My God, who turned on the steam." The steam

cut off valve was on a higher level up above the men who were working on the boiler and no one observed any one near the valve.

The only solution to the question was that some unauthorized person had opened the valve by mistake and noting his error, immediately turned it off again and silently retreated from the place so he was not detected. There is some doubt about the condition of the non-return valve and it is supposed to have been stuck in the open position. My opinion is that this type of valve should be tested out each time a boiler is cut out of service, to see that it closes properly before the main cut-off valve is closed.

Accidents of this sort emphasize the desirability of following strictly all safety rules, to hold certain parties responsible for each part of the work. The foreman should always be present when certain hazardous operations are under way and such operations should never be relegated to untrained or inferior helpers.

In this respect I believe the routine of operation by engineers on sea-going vessels is superior to that of land operating engineers for the following reasons. The sea-going shift engineer is required to come into the engine room at least five minutes before the time of his regular tour of duty,—he blows down the water columns of the boilers, notes the conditions of steam and whether the fires have been cleaned properly and whether all the force of firemen and coal passers are present; he feels all the bearings, and gets a verbal report from the off-going engineer if there is any trouble on the preceding shift. If there is a heated bearing the off-going engineer is required to stay on the shift as an aid until the trouble is removed. All these regulations make the operating force aware of his responsibility in connection with his particular duties and thus all parties are trained in discipline.

In the article in October issue reference is made to accidents of overspeeding of steam turbines. As a safeguard to this I think it is possible to test the overspeed trip of the turbine every time it is taken out of service by shutting it down that way.

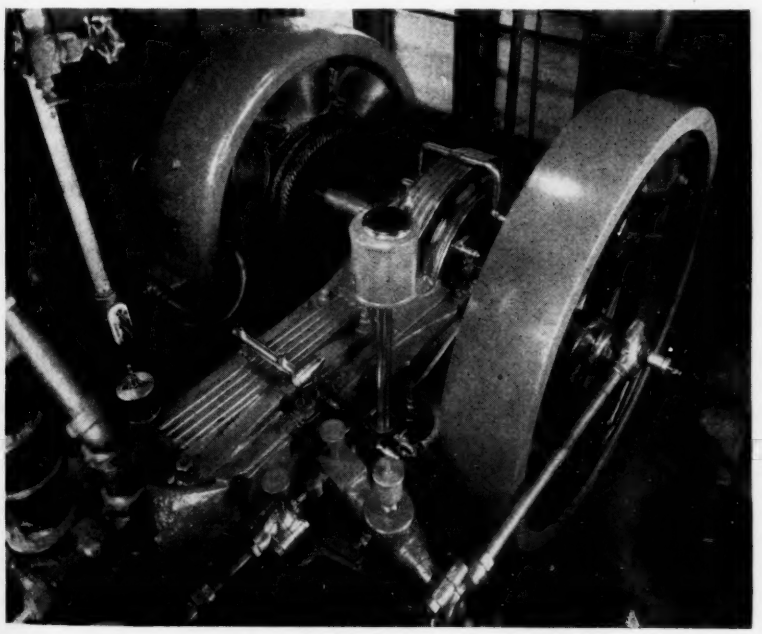
In arranging a safety routine for a power plant it is well to have a regular routine of periodic safety tests for all the apparatus that is liable to fail.

Thus an accident I recently witnessed might have been prevented. Most oil-switches of standard type are now equipped with disconnect switches just above them where they are connected to the mains. This enables them to be disconnected from the live parts of the switchboard so that the contacts of the switches can be inspected periodically for possible burned contacts. I recently was in a plant and saw an oil switch catch fire when an attempt was made to put it into service and the result was the whole plant was shut down for about an hour.

One of the power consumers was a foundry that was in the middle of a run and the iron in the cupola furnace become frozen fast and the whole furnace had to be torn down and rebuilt at an approximate cost of $8,000.00. The stores were full of customers when the lights went out and there was plenty of trouble for the light company.

Eternal vigilance is the price of dependable public utility service.

Logansport, Ind. C.C.C.



STILL RUNNING AFTER 43 YEARS

Illustrated above is a Skinner Engine (No. 6662), 8 by 12 in.; 25-kw General Electric D-C Generator, which has been in continuous service for over 43 years at Frederic B. Stevens, Inc., manufacturer of foundry equipment and supplies, fire brick; electroplating equipment and supplies, and buffing and polishing compositions at Detroit, Michigan. This engine has required very little upkeep expense, and M. Goodison who operates the engine reports that it is now going "stronger than ever"

LEAVES FOR THE BOOK

By K. H. Mack

In starting up a small pulverized-coal fired boiler we had planned to pick up the load November 6 and carry 60,000 to 65,000 lb per hr for two days to see the as hcondition, but as often happens our plans were upset by one of those things nobody could foresee.

To give you the story it is necessary to go back a bit. Out in the creek there are screens to keep leaves, sticks, etc., out of the plant water supply. These leaves are raked off daily and put in barrels and once a week the barrels are taken to the dump.

Halloween night the kids dumped three barrels of these leaves through a man-hole on the back side of the screens. Over the week-end these leaves caused a little difficulty, but from midnight Tuesday, one after another of the pumps became plugged up. By 9 a.m. Wednesday the entire plant was down flat. Every pump was plugged.

It took until 1 p.m. to get the lines clear in the boiler house so that we had water for the boilers. Heater lines were plugged, condensers stopped up, feed pumps so choked up that we had to take off the top half of the casing and flush them out with a fire hose.

As we were still not sure of conditions we fired with oil until 9 a.m. Thursday. During Wednesday night and Thursday morning we still felt the effect of the leaves in the boilers. Every now and then the steam temperature would take a dive from 445 F to 365 F, which is saturation temperature. We tried to combat this condition by blowing the boiler every two hours. By noon time we were at least keeping ahead of it and during the afternoon the temperature stayed up.

However, a water sample taken at 2 p.m. showed considerable dirt which settled out in the bottom of the water in a very few minutes. In view of this water condition it was decided not to push the boiler above the 50,000 lb per hr design load. In all probability there will be some difficulty with these leaves for several weeks.

ENGINEERS GOLDMINE

In the September 1946 issue of the of the Power Plant Engineering, H. E. Brooks gives a very interesting story of what he terms an engineers goldmine. I heartily agree with Mr. Brooks that such a vast store of ready information, as he refers to, is indeed an engineers goldmine. I consider that I have three such goldmines or, if you prefer to consolidate them all together, say just one large goldmine.

A good many years ago, when I was just starting in the engineering game. I was keenly interested in one particular piece of power plant equipment. Not

having access to the plant material on such items I wrote to the manufacturer that built it. I told him that I was studying engineering and that I would appreciate it if he could supply me with the information that I wanted. Also to send along books or literature on any other equipment of a like nature that he cared to. After several weeks the company sent me all of the books and literature on the machine that I could ever want. That was the beginning of my first goldmine. After that it was simple; I took paper and pencil and wrote the names and addresses of every name plate in the entire plant. I wrote to each and every one individually the same letter and received from every one the same gratifying results. They sent me something if it was only one typewritten sheet but most of the time they were all good books and material. In addition to this, I sent for all of the circulars and literature advertised in the various power plant magazines. As a result of these efforts I massed a store of information that is hard to equal anywhere. The best part of it is that it is all first hand information right from the manufacturers themselves. All clear authentic accurate data. Many, many times I have used this vast store of information for much needed data on problems and it is worth its weight in gold.

My second goldmine is of course my technical library. Quite a few years ago I conceived the idea that if a subject was worth knowing it was worth a book on it. Well, the result is a library that is wanting for very little. I have books on every subject pertaining to engineering and its related branches.

Now for my third goldmine. Several years ago, I was working with an engineer who was also deeply interested in engineering books and literature. One day he showed me some loose leaf data sheets that he was reading and there was the dawning of my third gold mine. These sheets are printed and sold by the Lefax Society of Philadelphia, Pa. and are known as the Lefax loose leaf data sheets. They are 3¾ in. by 6¾ in. and are perforated for six ring binders. They are available on any subject pertaining to engineering or its related branches. They contain all of the formulae, charts, curves, graphs, tables and scores of other information. They are small, quick to use and easy to carry anywhere. You can buy one or a thousand and every one will be the exact same size. I now have around 750 of these sheets and regard them highly.

Yes, it can be truly said that any engineer who owns and uses such great stores of knowledge really has a gold mine. In these stores lie secrets that we do not know or may have forgotten or cannot carry in our heads.

Of course, in speaking of goldmines, we must not forget to list the many power plant magazines among our treasures. It is these papers that keep us abreast of the ever advancing march of engineering and science. They keep us alive and enthusiastic in our job. The many articles, questions and answers: the many charts and curves, both the old and the new: the lists of new books and literature and many other items too numerous to mention are too valuable an asset to be overlooked.

CHARLES W. PARKS

Questions And Answers

Question No. 363

WHAT SHOULD HE DO ABOUT THIS EXCESS EXHAUST STEAM?

IN THE NORMAL operation of our refinery we produce large quantities of exhaust steam, a large portion of which we are now exhausting to the atmosphere. Some of this steam is used for preheating boiler feedwater, some for heating viscous oils in storage tanks, and some for heating buildings and in other phases of processing.

We are now contemplating the installation of low-pressure barometric turbines, (we assume this means condensing—Ed.) but even with this we will still have an excess of exhaust steam. We have another place where we might use the balance, but to date we have not found an economical solution for this problem. We have two fractioning towers operating at 20 and 27 psi, which require a total of 2500 lb per hr of steam. The pressure on these columns exceeds the pressure of our exhaust steam supply by some 10 psig, so for processing steam it is now necessary that we use live steam.

Our problem is to raise this 10-psi exhaust steam to approximately 30 psi steam so that we could use it in these towers.

Would it be possible for us to use some sort of compressor or some other means to accomplish this end? If you can find a solution to our problem, we would appreciate your comments at your convenience.

Michigan C.G.M.

Editor's Note: The steam could be compressed by a steam compressor driven by electric motor, as detailed in the article "What the Power Engineer Needs to Know About Steam Compressors" by G. D. Winans, January 1946 issue of POWER PLANT ENGINEERING, and the article "Steam Compressors Meet Need for High Pressure Steam" by C. G. Turgiss, August 1946 issue.

Another method of raising the pressure of the 10 psi steam to 20 or 30 psi would be by the use of a thermocompressor. This device is a steam jet compressor, operating on the same principle as the well-known injector or ejector.

Motive steam, which would be the live steam as initially generated in the boiler, is necessary for the thermocompressor and the resulting discharge is at a pressure somewhat higher than the low-pressure suction steam but not nearly so high as the motive steam.

Assuming that live steam were generated at 150 psig, that the exhaust steam is to have its pressure raised from 10 psig to 30 psig for use in the fractionating towers, then according to tabulations of steam consumption for such equipment, the thermocompressor would require approximately 1.75 lb of motive steam per lb of 10 lb vapor at the suction.

On the above basis it would require approximately 4500 lb per hr of motive steam at 150 psig to operate the thermocompressor at full capacity. However, all the low level heat would be utilized instead of being thrown away and a cost comparison of this method with the cost of throwing away the 10 psi steam would be very interesting.

Other possibilities are opened up by the above question and the following point should be investigated. Why is it not possible to install a low-pressure condensing turbine of sufficient capacity to utilize all the exhaust steam instead of leaving the excess to be wasted?

It may be that there is not enough condensing water available to condense all the exhaust steam that could pass through the turbine. Or it might be that the cost of providing all the water necessary would be too high.

Another possibility is that the amount of electric power that could be generated by the low pressure condensing turbine utilizing all the exhaust steam would be in excess of the electric power required in the plant.

However, those speculations lead to the following.

If it were possible to install a steam turbine generator, taking all the low pressure exhaust steam and generating from it a corresponding amount of electric power, then if there were any excess power, would it pay to utilize that in an electric boiler generating 30 psi steam for the fractionating towers, with the present reducing station held for standby to supply this steam in an emergency if the electric boiler had to be shut down

If all the exhaust steam could be passed through the low pressure condensing turbine and none of it wasted to atmosphere, then it might be economical

to operate another small turbine, taking throttle steam at full boiler pressure and exhausting at 30 psi to supply sufficient steam for the fractionating towers. This smaller turbine could drive a pump or some unit of process equipment or possibly an electric generator provided the additional electric power could be utilized.

The foregoing suggestions have all been made to C.G.M. who tells us that he is checking further into the various ideas and will advise us later as to his decision.

Meanwhile, we would appreciate comments from readers on this very interesting situation.

Question No. 364

DOES HE NEED TO GET RID OF THE BOTTLENECK?

IN OUR PLANT, a part of our building heating system is connected as shown in the accompanying sketch. This system was installed some 30 yr ago.

But this fall somebody raised the point that perhaps if we eliminated the bottleneck—the 1-in. section—in this

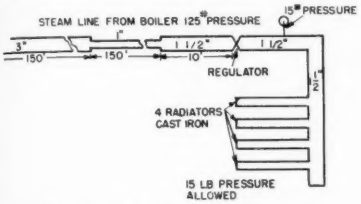


Diagram of L. T.'s heating system

line and increased it to 1½ in., we could get a greater volume of steam into the radiators.

My view is that as long as we can maintain the 15 psi pressure in the radiators and get the required heating effect from them, we don't need more volume of steam. All traps are in good condition.

Opinions of Q & A readers on this point will be appreciated.

Toledo, Ohio L.T.

Question No. 365

WHAT SHOULD BE DONE ABOUT THIS OLD PLANT?

OUR PLANT is very old. The first unit was installed in 1921. Since that time, it has been added to, until we now have a total of seven units—four units of 410 hp capacity each, three of 615, 613 and 611 hp respectively. These figures are at 100 per cent rating.

I feel that something ought to be done about this plant and would like to have Q & A readers comment on the details given below.

Our management feels that a steam generating plant is a dead overhead expense. They are of the opinion that, if it were possible to do so, it would be cheaper to buy steam and electricity than to generate it under any circumstances.

However, it is not possible to buy steam now and the plant must be accepted as a necessary evil. My problem is this: *Must* it be considered only as a necessary evil? Or can something be done to convert it into an asset? If so, what? And how can I convince the management of the desirability of doing this and the steps necessary?

Here are some operating data:

Our total maximum steam generation for one 15-min period has been 175,000 lb. The normal winter load averages about 140,000 lb per hr; summer load 100,000 lb per hr.

Coal consumption averages about 2800 tons a month. Strip mine coal is burned, its heat content being 13,800 Btu per lb. The feedwater temperature averaged, until recently, about 100 F. This I have increased to 200 F. Make-up feedwater averages about 95 per cent of total feedwater. This condition, however, will change when our new dewaxing plant goes into operation.

Six of the present boilers are straight-tube, horizontal-drum boilers. The seventh boiler is a cross-drum, bent-tube unit. Numbers 1, 3 and 4 are fired by multiple retort stokers. Numbers 2 and 5 are fired by single-retort underfeed stokers. Numbers 6 and 7 are fired with powdered fuel supplied by impact mills. Number 6 unit has a water-screen and back water-cooled wall. The number 7 unit has a suspended air-cooled wall and floor. Most of the boilers are equipped with connections for emergency oil burning.

There is some low pressure process steam from prime movers, but a good part of this is drawn through a reducing valve which, in my opinion, could be replaced by a prime mover. None of the condensate from any of the processing is returned to the boiler house. Upon the completion of the new dewaxing plant, there will be about 20,000 lb. of condensate returned to the steam plant.

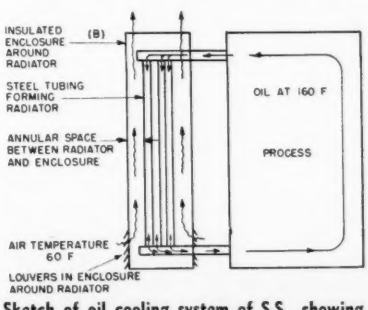
C.H.T.

Editor's Note—Naturally this problem demands a careful analysis by a competent consulting engineer.

Question No. 366

WOULD ENCLOSURE IMPROVE OIL COOLER?

ATTACHED is a sketch showing a cooling system including an air cooled radiator, through which oil circulates for cooling. Assuming unit quantities, would I gain any efficiency in the cooling if I "boxed in" the radiator allowing a reasonable air space around it as indicated in the sketch?


INSULATED ENCLOSURE AROUND RADIATOR (B)
STEEL TUBING FORMING RADIATOR
ANNULAR SPACE BETWEEN RADIATOR AND ENCLOSURE
AIR TEMPERATURE 60 F
LOUVERS IN ENCLOSURE AROUND RADIATOR
OIL AT 160 F
PROCESS

Sketch of oil cooling system of S.S., showing how he proposes to enclose radiator to create draft and improve effectiveness of radiator

It appears to me that I would, since the cooling air is confined in a definite area and the heating of the air would create a draft thereby drawing in air at the bottom louvers, the heat from the radiators supplying the impelling force. Could you give me information or formulas for calculating the radiation, heat transfer or cooling effect, to draw a comparison for both cases?

New York S.S.

Question No. 367

WHY DOESN'T THIS CHIMNEY PRODUCE ENOUGH DRAFT?

CAN A CHIMNEY be too large? A small saw mill operates two 66 in. x 16 ft HRT boilers fired with hog fuel and the total load is 200 to possibly 250 boiler hp. Frequently they cannot keep up steam pressure. They blamed the design of the Dutch oven furnaces.

But an inspection indicated a lack of draft. It would hardly pull a handkerchief in the ashpit door. There were no bad air leaks in the setting nor in the connections to the chimney. There were no instruments at the plant to take draft or temperature readings.

The chimney is steel and unlined. It is 80 ft high from the ground to the cinder screen and 7 ft in diameter. It has an area at least four times what would ordinarily be used for this load.

I am satisfied that the low velocity in this stack and the rapid cooling of the flue gas is the reason for the poor draft. If the temperature at various points in the stack were known and a calculation made of the resultant draft, it would probably prove the point. Unfortunately, the data for doing this are not available.

I have searched through handbooks and textbooks but have found no direct comment on low draft because of oversize chimneys. I would be interested to know if others have had experience with a similar condition and what was done to correct it.

I advised against increasing the height and suggested a vertical partition in the stack to reduce the area.

Chicago, Ill. L.H.

Editor's Note—This question is similar in many ways to Question No. 243 asked in the December 1943 issue. In the February, 1944 issue, many of the points raised above were discussed by J. G. Mingle. They are also well covered in his very practical article Calculation of Economy Chimney Size, page 8y, April 1942 issue of *The Practical Engineer and Electrician.* For detailed methods of chimney calculation, see the textbook by J. G. Mingle entitled Draft and Capacity of Chimneys (D. Van Nostrand Co.)

To calculate the amount of flue gas the boilers will pass to the chimney, when hogged fuel is burned, the methods and excess air charts for wood fuel are given in The Boiler Fireman's Handbook, by J. R. Darnell, Chapter 7, page 94, February 1946 issue *Practical Engineer and Electrician.*

Answer No. 345

WHERE SHOULD RELIEF VALVES BE INSTALLED ON ECONOMIZERS?

SHOULD THE relief valve be placed on the inlet or the outlet side of the economizer, asked J.W.W. in the October issue.

The consensus of the answers published in the December issue was that it should be on the outlet side. One reader gave a diagram showing all the valves required on the economizer. Below are more comments and another diagram.

Valve Should Be on Outlet

THE RELIEF valve for an economizer should be installed on the water outlet end between the stop valve and the economizer. I am including a sketch of

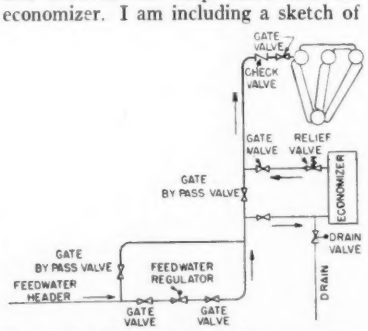


Diagram by McCormack showing economizer valving on his 4-drum Stirling boiler

the hook-up of an economizer to a 4-drum Stirling water-tube boiler in the plant at which I am employed. The gate valves are of the rising stem type.

New York JOHN MCCORMACK

He Would Install It on Inlet Side

THE WATER RELIEF valve, on moderate capacity units, should be placed on the economizer inlet and should be set to open at a pressure of 50 lb in excess of the boiler safety valve, plus the water pressure drop across the economizer.

In my opinion, the main stop and check should be placed between the economizer and boiler, and the feedwater regulating valve should be installed at the economizer inlet.

Baltimore, Md. MARVIN M. PERSINGER

Answer No. 349

HOW TELL WHETHER COAL OR OIL IS CHEAPER TO BURN?

WITH 14,000-Btu coal at $10.50 per ton and Bunker C oil at $52.00 per thousand gallons, which is cheaper to use? Asking this in the November issue, H.G.C. called attention to the fact that efficiency of utilization must be considered and that under varying conditions there will be different answers.

Comments from Wenig

GENERALLY SPEAKING, whenever the question of which fuel is cheaper to use, several factors (in addition to the actual cost—Btu's for one cent) have to be known. In addition, we must know the particular application for the fuels to each specific problem. I assume that your plant is at present burning coal.

In the choice of coal or oil, consider the following:

A. COAL

1. Cost of coal, Btu's per cent:

$$\frac{\text{Btu per lb} \times 2000 \text{ lb}}{\text{Cost per ton in cents}} = \text{Btu for one cent}$$

$(4000 \times 2000) \div 1050 = 26{,}666$ Btu for one cent

2. Cost of handling coal; i.e., storage, unloading, etc.

3. Cost of firing, i.e., coal passers, and/or power of stoker.

4. Cost of removing ashes.

Is the boiler designed to burn this fuel economically?

B. OIL

1. Cost of Oil, Btu's per cent:

$52.00 per 1000 gallons as usually purchased, 8 lb of oil is equal to 1 gal of Bunker "C" oil (#6). Therefore 8000 lb is equal to 1000 gal. 19.000 Btu average heat content per lb of Bunker "C" Oil.

$(19000 \times 8000) \div 5200 = 29{,}231$ Btu for one cent

2. Cost of storage capacity, i.e., tanks, etc.

3. Steam and Pumps needed to heat and pump oil.

4. Power or Steam needed to atomize oil at burner.

Is this furnace designed for or will it be easily adapted to the use of oil?

All the above factors must be taken into consideration before one can say either fuel is the better.

Brooklyn, N.Y. ARTHUR J. WENIG

Answer No. 350

WHY DO HIS AUTOMATIC STOP VALVES CHATTER?

DESCRIBING the steam-using equipment supplied by his 30-hp water-tube boilers, C.G.C. asked, in the November issue, what could be causing a severe chatter in the automatic stop valves on the boilers? He said he had been maintaining steam pressure accurately, had drilled holes in the valve pistons, had screwed down on the valve stems—nothing seemed to stop the chatter.

Among the comments from readers are suggestions for stopping a possible "hunting" effect in the valves by using a friction ring on the valve piston. Other readers say receiver separators in the steam lines will smooth out pulsations that may be causing the chatter.

Not Enough Receiver Volume, Says Webber

IN MY OPINION, the chattering of the stop valves on the boilers that C.G.C. is operating is being caused by a deficiency of receiver separator volume.

It is considered good practice to place a receiver separator in the steam piping adjacent to the engine with a volume of three or four times that of the engine cylinder. The volume of steam in this receiver acts as a cushion for absorbing the force of the blows caused by the cutoff. This force with a medium or high-speed engine, may be quite high.

C.G.C. does not state the speed at which his engines operate but undoubtedly they are high-speed engines. As the stop valves are 6 in., the header is evidently of the same diameter, which to my notion is none too large considering the several services that are being supplied from it. The header and steam supply lines to the engines, being fully loaded if not at times somewhat overloaded, would cause the cutoff pulsations to carry back to the stop valves, producing the chatter or vibration.

I would suggest that C.G.C. affix a steam gage to the steam line between the separator and the engine throttle to determine the pressure drop between the header and the throttle. If the pressure difference is excessive (depending of course upon the length of the steam line) a larger receiver separator should be installed at the first opportunity. A pressure drop of from 1½ to 2 lb is usually allowed per 100 ft of pipe.

Duluth, Minn. E. R. WEBBER

Suitable Receiver Will Cure Trouble, Says Cuttitta

C.G.C. has not stated whether a receiver or receiver separator is installed to supply steam to his two steam engines. If I am correct in my assump-

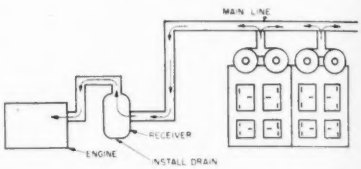


Diagram by A. F. Cuttitta showing how receiver separator should be installed ahead of engines to prevent pulsations causing valve chatter

tion that he has not, I am almost certain his condition will be remedied by installing it as shown in the accompanying sketch.

Passaic, N.J. A. F. CUTTITTA

Friction Rings on Valve Pistons Solved Similar Problem

WE HAVE three 150-hp HRT boilers and each has a 6-in. angle non return valve. About 15 yrs ago we had a man out from the manufacturer of these valves to see why they chattered, and what could be done about eliminating it.

I believe we had trouble only when too little steam was being used for the size of valve. Seems to me that this

Sketch by Bros. Giesen showing how ring on valve piston stopped chatter

condition is something like "hunting" of a governor on a steam engine, or of a pressure regulator with weights. Anyway the man from the company recommended installing a friction ring on the valve disc, since there was a groove provided for this purpose. For some reason, these rings were not furnished with the valves originally. We followed their suggestion and have had no trouble since then with the valves. These friction rings are very much like a piston ring, and are fitted on to the valve disc in a similar manner.

Westmont, Ill. Bro. JOHN J. GEISEN
St. Joseph's Seminary

Answer No. 351

WHY DOES HE HAVE TO ROLL TUBES OFTENER?

WITH A WIDELY varying load on his 200-hp HRT boilers, with the boiler water kept near zero hardness, but with chlorides sometimes a bit high, why should he have to roll boiler tubes much often than he used to? asked L.L.C. in the November issue. Also, should he weld the tube ends to the tube sheets?

Look to Load, Feedwater, Internal Conditions, Weld Only on Inspector's Approval

L.L.C. seems to be experiencing something quite common to such varying load conditions.

Solids concentration will surely make matters worse. Re-rolling of tubes, if not expertly done, will further complicate matters. There should be every consideration towards leveling off load conditions as much as possible. Feedwater should not only be analyzed but the boilers should be opened and entered to make certain of internal conditions.

Change of feedwater discharge location within these boilers, and possibly change of firing methods, would help.

Fusion welding of tubes is not an uncommon practice these days, provided condition of the tubes justifies cost of such repairs.

In this case, welding will aid; but unless cause of troubles leading to the tube leakage are not eliminated, additional and more expensive repairs may result, since cracking of tubes, tube sheet and welding may occur.

A welded tube is more difficult to remove. Do not forget that fusion welding on the tube sheet, unless completely removed, will make it difficult to properly roll and bead new tubes.

Before re-rolling or welding these tubes, a competent boiler inspector should be consulted, since their holding strength may already be dangerously impaired and re-rolling or fusion welding might not be safe.

Pittsburgh 16, Pa. J. W. STUTHERS

Approved Welding Stopped Similar Trouble

THE QUESTION of leaky tubes in L.L.C.'s HRT boiler brought back memories of the time we had here with our 150-hp boiler which was operating under similar conditions.

Our boiler was subjected to a fluctuating load of anywhere from 50 hp to 300 hp. For a time things went well, but first thing we knew we started to get small leaks at the back tube sheet. These tubes were rolled and they leaked under a test. I suggested, after rolling the tubes, to bead the tube ends to the tube sheet.

After this was done the tubes stayed tight until one of our firemen, who is not with us any more, worked at night over the week end. The following morning about half of the tubes on the upper rows were leaking quite badly. We had to shut down the boiler and roll and bead the tubes. After a thorough investigation we found out that the boiler water was allowed to get too low, hence the leaks. Under a high load with low water, the back head or tube sheet is subjected to considerable heat and as the load fluctuated the water level went up and down. In our case the fireman was not on the job.

Since that time, we have replaced these tubes with new ones and, with permission of the Department of Licenses, we had every tube on the back tube sheet welded, after rolling. Since that time, which was about 9 years ago, we haven't had one leak other than a fusible plug, which would have to be replaced about once a year.

Ridgefield, N.J. J. F. SLAVINSKY

Welding Stopped His Trouble

L.L.C. says nothing about how long the boilers have been in use, but his load varies a lot, which may have something to do with his tubes leaking. We had similar difficulties with one of our boilers, and most of the trouble was due to cold draft entering the smoke box and hitting the front head of the boiler when blowing flues, which we do twice a day.

Our boilers have been in use 20 yr and rolled tubes in this boiler a number of times, until they failed to hold. Then we had a boiler maker examine them and he suggested welding around each tube in the front head. We had him do this and it ended our trouble with leaking tubes. As regards the cause of the trouble—cold draft on the front head when blowing tubes—we have continued to blow them as before.

Westmont, Ill. Bro. JOHN J. GEISEN
St. Joseph's Seminary

Answer No. 352

CAN HE USE THE EARTH TO REDUCE TEMPERATURE OF COOLING WATER?

TO ABSORB heat from refrigerant cooling water, reducing its temperature from 95 F to 70 F, could he use pipe buried in the ground? asked L.F.C. in the November issue. If so, how could he figure the heat transfer—that is, the amount of pipe required?

Small Has His Doubts, Says Big Inch Might Do It

THIS QUESTION calls to mind the old remark, "It's a good trick if you can do it."

No statement was made of the quantity of water to be cooled from 95 to 70 F, but as 6-in. pipe was mentioned, perhaps 200,000 lb per hr is not wide of the mark. Sub-surface temperature is undoubtedly a function of depth, exposure, nature of soil, season, and geograph, but drawing on our theoretical knowledge of cellars, beer and cyclone, 55 degrees is not unreasonable. We cannot, however, use this in calculating heat transfer; for this temperature, even if indicated by test, would not prevail if heat were constantly poured in from the proposed cooling system. The earth would have no means of getting rid of this heat except by radiation and, in the summer especially, the temperature would be bound to rise.

Let us rush in where angels fear to tread and assume a constant temperature of 60, which would give us an AMTD of 22 degrees. A logarithmic mean would be correct, but why go into that when we are only guessing? L.F.C. gives transfer rates of 0.9 Btu for moist earth and 0.2 for dry earth. Averaging these values we get

$$\text{Required surface} = [(200{,}000) \times (95\text{-}70)] \div (22 \times 0.55) = 406{,}000 \text{ sq ft}$$

That is a lot of pipe, regardless of the diameter and if I have made a mistake of a few hundred per cent it is still a lot of pipe, and the cost of same would pay for a lot of water cooling. Perhaps if the Big Inch and the Little Big Inch pipe lines could be rented, they might be tied together and make an ideal cooler, if you don't care about pressure drop.

Chicago 5, Ill. E. S. SMAIL

Wenig Doesn't Think The Earth Will Do It

I ADVISE against the use of an underground pipe or pipes for cooling condenser water. The earth around the pipes will absorb a certain amount of heat and then this heat absorption will stop or slow down to such a small heat transfer coefficient as to be practically zero. If such a plan were practical, you may rest assured that many plants, refrigerating and otherwise, would have put it to good use.

I would recommend the use of evaporative condensers or, if your plant is too large, use cooling towers, either natural, induced, or forced draft.

Brooklyn, N.Y. ARTHUR J. WENIG

RECENT developments in the heat pump have greatly increased the interest in heat transfer between bare pipes and ground. Two heat pump units (now being manufactured commercially) will use a coil buried in the earth as a heat exchanger.

Accordingly, various attempts have been made recently to assemble the existing data on the subject. The best review of it is given in an article entitled Heat Pump Heat Sources by E. N. Kemler of Southern Research Institute on page 339 of the October 1946 *Edison Electric Institute Bulletin.*

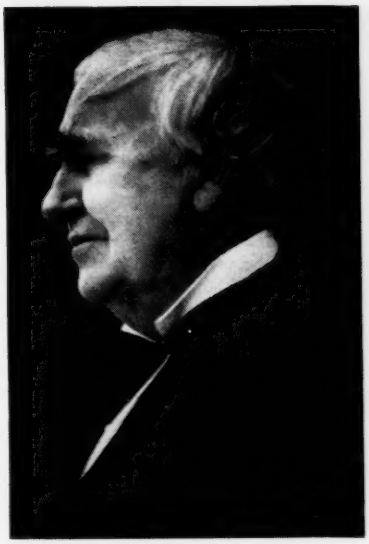
By using the data for heat transfer and temperature differences given in that article, it should be possible to calculate the amount of pipe surface required for the conditions outlined in the original question.

Bus Bar Weights

Dimensions	Approximate Weight Per Foot	Dimensions	Approximate Weight Per Foot
3/8" x 3/32"	.136 lbs.	1 1/4" x 3/8"	1.810 lbs.
3/8" x 1/8"	.181 lbs.	1 1/2" x 3/32"	.545 lbs.
1/2" x 1/16"	.120 lbs.	1 1/2" x 1/8"	.723 lbs.
1/2" x 3/32"	.181 lbs.	1 1/2" x 3/16"	1.085 lbs.
1/2" x 1/8"	.241 lbs.	1 1/2" x 1/4"	1.447 lbs.
1/2" x 3/16"	.361 lbs.	1 1/2" x 5/16"	1.820 lbs.
1/2" x 1/4"	.482 lbs.	1 1/2" x 3/8"	2.170 lbs.
5/8" x 1/16"	.150 lbs.	1 1/2" x 1/2"	2.890 lbs.
5/8" x 3/32"	.221 lbs.	1 1/2" x 3/4"	4.340 lbs.
5/8" x 1/8"	.301 lbs.	1 3/4" x 1/8"	.844 lbs.
5/8" x 3/16"	.452 lbs.	1 3/4" x 3/16"	1.266 lbs.
5/8" x 1/4"	.603 lbs.	1 3/4" x 1/4"	1.688 lbs.
3/4" x 1/16"	.181 lbs.	2" x 1/8"	.964 lbs.
3/4" x 3/32"	.272 lbs.	2" x 3/16"	1.450 lbs.
3/4" x 1/8"	.361 lbs.	2" x 1/4"	1.930 lbs.
3/4" x 3/16"	.542 lbs.	2" x 5/16"	2.420 lbs.
3/4" x 1/4"	.723 lbs.	2" x 3/8"	2.890 lbs.
3/4" x 5/16"	.910 lbs.	2" x 1/2"	3.860 lbs.
3/4" x 3/8"	1.090 lbs.	2" x 3/4"	5.790 lbs.
3/4" x 1/2"	1.450 lbs.	2 1/4" x 1/4"	2.170 lbs.
7/8" x 1/16"	.211 lbs.	2 1/2" x 1/8"	1.200 lbs.
7/8" x 3/32"	.318 lbs.	2 1/2" x 3/16"	1.810 lbs.
7/8" x 1/8"	.422 lbs.	2 1/2" x 1/4"	2.410 lbs.
7/8" x 1/4"	.844 lbs.	2 1/2" x 3/8"	3.620 lbs.
1" x 1/16"	.241 lbs.	2 1/2" x 1/2"	4.820 lbs.
1" x 3/32"	.363 lbs.	3" x 1/8"	1.450 lbs.
1" x 1/8"	.482 lbs.	3" x 3/16"	2.170 lbs.
1" x 3/16"	.723 lbs.	3" x 1/4"	2.890 lbs.
1" x 1/4"	.964 lbs.	3" x 3/8"	4.340 lbs.
1" x 5/16"	1.210 lbs.	3" x 1/2"	5.790 lbs.
1" x 3/8"	1.450 lbs.	3 1/2" x 1/4"	3.370 lbs.
1" x 1/2"	1.930 lbs.	4" x 1/8"	1.930 lbs.
1 1/4" x 3/32"	.454 lbs.	4" x 1/4"	3.860 lbs.
1 1/4" x 1/8"	.603 lbs.	4" x 3/8"	5.790 lbs.
1 1/4" x 3/16"	.904 lbs.	4" x 1/2"	7.720 lbs.
1 1/4" x 1/4"	1.206 lbs.	5" x 1/4"	4.820 lbs.
1 1/4" x 5/16"	1.510 lbs.	6" x 1/4"	5.790 lbs.

Reprinted Courtesy Pelham Electric Mfg. Corp.

Thomas Alva Edison Born 100 Years Ago



Born at Milan, Ohio, February 11, 1847, Thomas Alva Edison, from the age of ten until his death in 1931, was furnishing proof that "Genius is 10 per cent inspiration and 90 per cent perspiration." His never-failing sources of physical and mental energy gave the world two of its outstanding amusements—the moving picture and the phonograph—which also have served as two of our greatest educational media. The time for man to enjoy these products of his genius was made possible largely through Edison's development of the electrical generating and distribution systems . . . systems which have spread around the world from the Pearl Street and Sunbury plants. In all, he was granted 1,097 American patents, the most ever issued to an individual

EDISON'S MOST famous invention and the one for which he is best known is the invention of the first successful incandescent lamp. In 1877, Edison devoted his efforts and those of his staff to the use of carbon in some shape or form in electric circuits. In September of that year, when Edison turned his thoughts actively toward electric lighting by incandescence, it was therefore only natural that his experiments should be in the line of carbon as an illuminant.

One of his first experiments was the bringing to incandescence of a strip of carbon in the open air to ascertain merely how much current was required. This conductor was a strip of carbonized paper about an inch long, one sixteenth of an inch broad, and six to seven one-thousandths of an inch thick, the ends of which were secured to clamps that formed the poles of a battery. The carbon was lighted up to incandescence and, of course, oxidized and disintegrated immediately. Within a few days this was followed by experiments with the same type of carbon, but "in vacuo" by means of a hand-worked air-pump. This time the carbon strip burned for about eight minutes. Various expedients to prevent oxidization were tried, such as coating the carbon with powdered glass which in melting would protect the carbon from the atmosphere, but without successful results.

Edison next worked with such infusible metals as boron, ruthenium, chromium, etc. as separators between two carbon points, the current acting so as to bring these separators to a high degree of incandescence, at which point they would emit a brilliant light. He also placed some of these refractory metals directly in the circuit, bringing them to incandescence and used silicon in powdered form in glass tubes placed in the electrical circuit. Edison's conclusions on these and the other substances which he tried at the time was that they did not reach the ideal that he had in mind for commercial results. Edison's systematized attacks on the problem were two in number, the first of which related above began in September, 1877, and continued until about January, 1878. The excitement occasioned by the invention of the phonograph in August, 1877, occupied Edison's time until about July, 1878, when he went on a expedition to Wyoming to observe an eclipse of the sun, and incidentally to test his tasimeter, a delicate instrument for measuring heat transmitted through immense distances of space.

Upon his return from the trip he again started work on the incandescent lamp. After having devoted several months to experimental trials of carbon, at the end of 1878 he turned his attention to the platinum group of metals. He began a series of experiments in which he used chiefly platinum wire and iridium wire and alloys of refractory metals in the form of wire burners in incandescent lamps. These metals were found to last longer than the carbon strips previously used when heated up to incandescence by the electric current although under such conditions as were then possible, they were melted by excess of current after they had been lighted a comparatively short time, either in the open air or in such a vacuum as could be obtained by means of the ordinary air pump. Nevertheless, Edison continued along this line of ex-

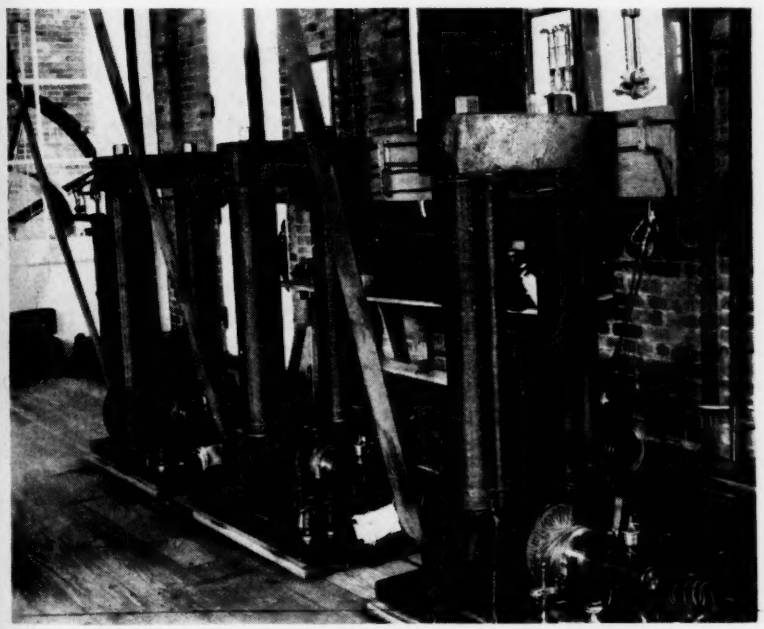


Fig. 1. This is the long-waisted "Mary Ann Dynamo" which Edison developed in 1879. It was the first electric generator with an efficiency of more than 50 per cent

periment with unremitting vigor, making improvement after improvement until about April, 1879, he devised a means whereby platinum wire of a given length which would melt in the open air giving a light equal to only four candles, would emit a light of twenty-five candlepower without fusion. This was accomplished by introducing the platinum wire into an all glass globe completely sealed and highly exhausted of air and passing current through the platinum wire while the vacuum was being made. In this, which was a new and radical invention, we see the first step in the development of the modern incandescent lamp. During these experiments with a great variety of lamps of the platinum iridium type, Edison kept his laboratory going without cessation.

Work With High Vacuum

About August he had obtained a pump that would produce a vacuum to about one hundred-thousandth part of an atmosphere and at sometime during the next month or at the beginning of October, he had obtained one that would produce a vacuum up to one millionth part of an atmosphere. The conditions for maintaining this high vacuum were only made possible by Edison's invention of the one-piece all glass globe in which all the joints were hermetically sealed during its manufacture into a lamp whereby a high vacuum be retained continuously for any length of time. After attaining a high degree of perfection with the platinum iridium type lamp, he recognized its impractical character and his mind reverted to the opinion he had formed in his early experiments two years before that carbon had the requisite resistance to permit a very simple conductor to accomplish the object if it could be used in the form of a hair-like 'filament' provided the filament itself could be made sufficiently homogeneous.

Resumes Work With Carbon

Now, that Edison had found means for obtaining and maintaining high vacua, he immediately went back to carbon. On October 21, 1879, after many patient trials he carbonized a piece of cotton sewing thread bent into a loop or horseshoe form, and had it sealed into a glass globe from which he exhausted the air until a vacuum up to one-millionth of an atmosphere was produced. This lamp, when put on the circuit, lighted up brightly to incandescence and maintained its integrity for over forty hours, and the practical incandescent lamp was born. With this lamp, he made the discovery that the filament of carbon, under the conditions of high vacuum, was commercially stable and would stand high temperatures without the disintegration and oxidation that took place in all previous attempts that he knew of for making an incandescent burner out of carbon. This lamp also possessed characteristics of high resistance and small radiating surface, permitting economical outlay for conductors, and requiring only a small current for each unit of light—conditions that were absolutely necessary of fulfillment in order to accomplish commercially the subdivision of the electric-light current.

Fig. 3. It was in this building that the first three-wire central station for electric lighting started operation on July 4, 1883, at Sunbury, Pennsylvania

Between October 21, 1879 and December 21st of that year some hundreds of these paper-carbon lamps had been made and put into actual use, not only in the laboratory, but in the streets and several residences at Menlo Park. On New Year's Eve, 1879, special trains were run to Menlo Park for the demonstration of incandescent lighting which was held there at that time. However, Edison was not satisfied with paper carbons. In his search for carbons, he carbonized everything in his laboratory and then commenced carbonizing just about every conceivable material. He finally found a bamboo which met his requirements. The story of the bamboo hunt is an article in itself, but the bamboo-filament lamp was only one item of a complete system which Edison devised—a system which completely revolutionized the art of interior illumination.

First Lighting System at Menlo Park

Menlo Park, New Jersey, was the first actual electric lighting central station, supplying and distributing incandescent lamps and some electric motors by means of under-ground conductors imbedded in asphalt and surrounded by

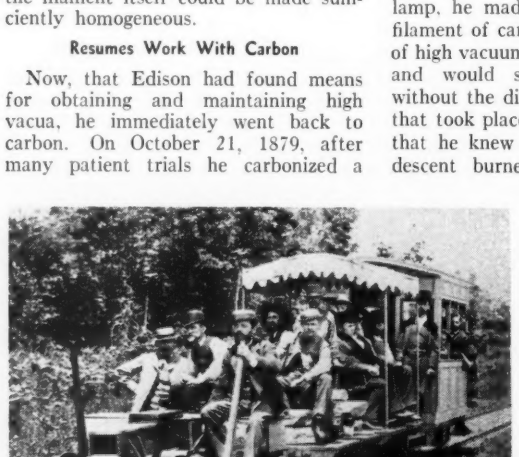


Fig. 2. In May, 1880, Edison started operation of the first passenger electric railway in this country at Menlo Park, New Jersey. His early work on the electric railway was the fore-runner of today's vast electric railway network

a wooden box. Edison had outlined the work he had to do "invent a system." It was during this period that he did so much of his work with good results in the design and perfection of dynamos. The principal improvements he made in dynamo electric generators were of a radical nature and remained in the art. As different as the dynamos of today are from those of the earlier period, they embodied essential principles and elements that Edison's men worked out and elaborated as the conditions to success.

In the summer of 1881, Edison designed, built, and shipped to Paris, for the first electrical exposition ever held, the largest dynamo that had been built up to that time. It was capable of lighting 1200 incandescent lamps and weighed with its engine 27 tons, the armature alone weighing 6 tons. It was then, and for a long time after, the eighth wonder of the scientific world, and its arrival and installation in Paris were eagerly watched by the European physicists and electricians.

In January, 1880, Edison applied for a patent on his "system of electrical distribution." The patents were issued on August 30, 1887. Fundamentally, it covered multiple arc distribution. Mr. Edison made a number of other applications for patents on electric distribution during 1880. Among these was the one covering the celebrated "Feeder" invention, which obviated the "drop" in pressure, rendering lights dim in those portions of an electric-light system that were remote from the central station.

These two patents alone were absolutely basic and fundamental in effect, and both still are put into actual use wherever central-station lighting is practised. Edison's grasp of the principles of a true system, which basically has not changed today, is shown.

In 1880, Edison had made application for 60 patents, of which 32 were in relation to incandescent lamps—seven covering inventions relating to distributing systems—five had reference to inventions of parts, such as motors, sockets, etc.—six covered inventions relating to dynamo-electric machines—three related to electric railways—seven to miscellaneous apparatus, such as telegraph relays, magnetic ore separators, etc.

In the period of twenty-eight years, from 1880 to 1908, Edison took out no fewer than 375 patents on electric lighting alone. These patents covered not only incandescent lamps, but also distributing systems, dynamo electric machines, and such minor but important parts as sockets, switches, fuses, safety catches, meters, underground conductors, etc.

The Three-Wire System

The "Three Wire" system which Edison patented in 1882, eliminated the need for large copper conductors running directly from the central station to all parts of the districts. The large conductors were necessary to prevent a drop of pressure at the ends most remote from the station which caused the lights there to burn with a noticeable diminition of candle-power. The "Feeder" and "Three-wire" inventions enabled electric light to compete with low price gas and are still in use today. The first "Three-wire" system central station was in operation July 4, 1883, at Sunbury, Pennsylvania.

During 1881 and until September, 1882, Edison was continually busy with his plans for a central incandescent lighting station. He devised a system whereby the wires could be laid underground and, of course, with this system he had to provide an entire electric lighting system and also check the residences of those who were to be his customers.

On September 4, 1882, the Pearl Street Station was officially started by admitting steam to the engine of one of the "jumbos," current was generated and turned into the network of underground conductors and was transformed into light by the incandescent lamps that had thus far been installed. Except for a few minor mechanical and engineering annoyances the station operated uninterruptedly for eight years. At first only one dynamo was put into operation and it was not until a short while thereafter that Edison operated several dynamos in parallel to produce current from this station. Before he could do so, he had to make a number of revisions to cut down torsion of the shaft so that the governors ran together all right.

The year 1883 was significant for Mr. Edison in that by his discovery of what was to become known as the "Edison Effect" he pushed aside a veil of darkness, behind which were to be found the wonders of electronics. Mr. Edison in this achievement discovered the previously unknown phenomenon by which an independent wire or plate when placed between the legs of a filament in an electric bulb served as a valve to control a flow of current. This discovery covers the fundamental principles on which rests the modern science of electronics. In the same year, Edison filed a patent on an electrical indicator employing the "Edison Effect," the first application in the field of electronics. With Wilhelm Konrad Roentgen's discovery of the X-ray in 1895, Edison turned his attention to the mysteries of these invisible rays. Edison said with regard to this work "when the X-ray came up, I made the first fluoroscope using tungstate of calcium. I also found that this tungstate could be put into a vacuum chamber of glass and fused to the inner walls of the chamber and if the X-ray electrodes were let into the glass chamber, the proper vacuum was obtained, you could get a fluorescent lamp of several candle-powers."

Edison did not patent the fluoroscope but chose to leave it to public domain because of its universal need in medicine and surgery. On May 16, 1896, he applied for a patent on the first fluorescent electric light, an invention which stemmed directly from his experimentation with the X-ray.

STARTING UP STEAM GENERATORS

(*Continued from Page 73*)

tablished to give good burner ignition and satisfactory combustion conditions.

And So to Bed

Some hours later the service engineer decides that he can now leave the unit long enough to snatch a few hours sleep. It is after 2:00 a.m. and he makes a quick survey of the main office trying to find a vacant desk to curl up on to go to sleep. Some offices are locked and others are occupied. It is apparent that very few of the men connected with the plant are sleeping at home tonight. The grotesque position of the assistant superintendent, sleeping with his feet in the air propped up on the desk, his body suspended in an uncertain swivel chair amuses the tired engineer. He wonders what would happen if he should give the chair an easy but quick shove, but decides that securing the customer's good will may also be an important part of his job. He is too tired to spend any great amount of time looking for a place to sleep and a few minutes later is curled up on a pile of insulation boxes over in a dark corner of the boiler room.

The starting-up day is done and as the tired service engineer settles down to sleep the low rumble of the pulverizers, the soft whisper of the rushing air, the hum of the fans, the song of the turbine and the intermittent sound of men's voices blend into a medley of assurance that all is well. The new boiler unit is operating smoothly and he knows that after a short period of initial operation the unit will give dependable, economical service to all those people whose lives will be brighter because of its existence. The tired men who have this day stirred the huge metal giant into useful service, sleep the sleep of the weary and even in sleep many minds are subconsciously planning the days ahead knowing that many duties remain to be finished before the new power plant is actually to be considered as a reliable source of ever-available power.

EVERYONE ABHORS the thought of another war, yet consider the results of our "daily war"—with traffic. From Pearl Harbor to V-J Day the traffic toll reached 3,394,000 dead or injured. Our battlefield sacrifice was 1,070,524. And with gas rationing gone and speed laws relaxed, accidents have increased 35%!

THE SPECTACULAR aspects of the atomic bomb tend to overshadow other contributions to the war effort. Two billion dollars for the cost of the bomb is a large sum, but, the electronic industry can gain satisfaction from the fact that even more was spent on radar research and development, $2,700,000,000.

Additional Topping Under Way at Sherman Creek

One new 1,000,000 lb per hr steam generating unit takes the place of six old 650 hp, 200 psi boilers at Sherman Creek Station of the Consolidated Edison Company of New York. This constitutes the second unit of the topping program at this station. The unit now under construction is expected to go into operation some time this year

By R. T. ROBERTS
Division Engineer, Mechanical Engineering Dept., Consolidated Edison Co. of New York

THE FIRST UNIT of the Consolidated Edison Company's topping program at Sherman Creek went into operation in 1943. This unit was a 50,000 kw turbine and a 1,000,000 lb per hr boiler with steam at 1600 psi and 950 F and was described in POWER PLANT ENGINEERING, September 1943.

The second unit, No. 100, of this program is now being erected for operation in 1947. When consideration of this boiler was under way, all of the factors entering into the choice of the first boiler still remained; therefore, in order to take advantage of the maximum economies offered by duplication in arrangement and design and the lower investment in spare parts, a Combustion Engineering Company boiler, generally duplicate of the first unit, was ordered.

No. 90 boiler faces west and it was the intention in 1943 that No. 100 would face east. However, when design was started it was found that a more satisfactory arrangement could be made if the new boiler were turned to face west also. This required a longer steam lead which now is 17½ in. O.D. and runs around the boiler to the turbine. As is the case with No. 90, the Boiler Code covers this piping up to, and including, the turbine throttle valve. In the steam lead, carbon molybdenum forged pipe, A.S.M.E. Specification SA-266, has been used, except that the chemical analysis, tensile strength, yield point, elongation and heat treatment conforms to A.S.M.E. Specification SA-209 Grade T-1.

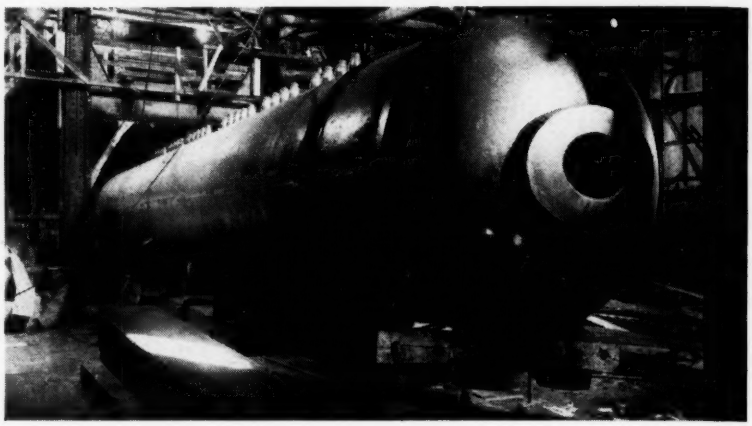


Fig. 2. This is a view of the main steam drum on the station floor preparatory to hoisting

Six 650 hp, 200 psi boilers were removed to provide room for the new installation.

Three years of operation of boiler No. 90 has been very satisfactory but has brought to light the need for slight changes from the original design in order to meet more nearly the present service conditions. While the original design specified a wide range of fuel, it was found that higher ash and lower fusion coals needed to be considered.

Superheat temperatures were high at times. Therefore, the superheater surface was reduced from 30,712 sq ft to 28,240 sq ft. Three rows of screen tubes were placed in front of the superheater instead of two rows as in Boiler No. 90.

In order to insure against low steam temperature at low loads, provision for four auxiliary burners was made in the front wall of Boiler No. 90. These burners have been omitted in the new boiler.

As a precaution against external tube corrosion, furnace tubes have been aluminized for the lower 19 feet.

Boiler No. 90 showed a tendency to slag the superheater with certain coals, therefore, a Diamond Power Speciality Company sequential system of soot blowers is being installed in both No. 90 and No. 100. This installation consists of an additional band of side wall blowers around the furnace at approximately elevation 50 ft 8 in., and three pairs of retracting blowers in the furnace, one under the arch and two at the superheater inlet.

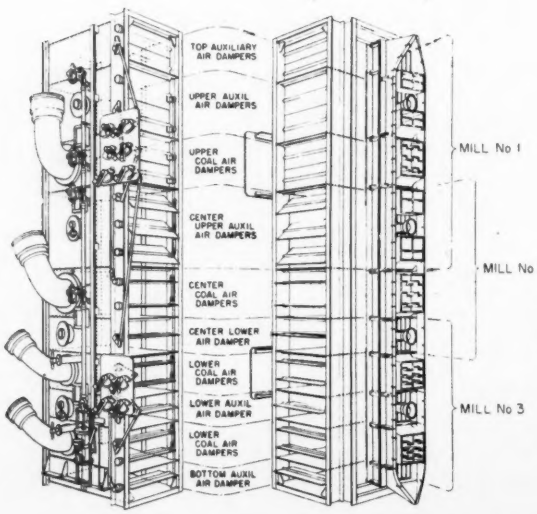


Fig. 1. Burner arrangement for the No. 100 unit is substantially the same as for No. 90 with the exception that four auxiliary burners in the front wall of No. 90 boiler have been omitted in this unit

Due to restricted conditions, three water cooled telescopic blowers are used on the south side, while on the north side, steam cooled retractable blowers were used. The eighteen air cooled roof blowers were omitted. Other blowers are generally similar to No. 90 and all were coupled into an air controlled sequence system.

This system is so arranged that any group of blowers can be cut out of the sequence and by a simple operation of handles on a control board the entire system can be put in operation, the boiler blown automatically and the system automatically stopped when all points previously selected have been blown.

In order to provide closer superheat regulation, the by-pass damper was made with a pair of auxiliary reciprocating leaves. As the main damper opens, due to impulses created by high steam temperature, the auxiliary dampers approach each other, partially closing off passage of gas through the lower portion of the superheater. A greater amount of gas then passes only the upper portion of the superheater and directly to the economizer through the dead pass, greatly reducing the effective gas touched surface of the superheater.

Fig. 4. The steam drum is shown in this photo after it was hoisted into position

Due to the Company's established policy of acid washing the units at definite scheduled intervals, additional vent, drain and blowoff connections were installed on boiler No. 100 so as to reduce the time required for filling and emptying the boiler.

It is the intention, at some time, to make the automatic boiler regulation more closely follow the turbine load, and to this end, response to load changes is being speeded up. The bowl mills of No. 90 were changed so that the bowl is now built more shallow than previously and with a flat bottom. This feature alone has cut response time in half. While the rating of the No. 90 and No. 100 mills is nominally the same, the worm gear has been increased in size in No. 100 to reduce maintenance, and a forced feed lubrication has been added. The exhauster wheels are 2 in. larger on the new mills and are equipped with a set of auxiliary vanes called whizzers. The whizzer vanes are of smaller diameter than the main wheel and are located at the exhauster inlet. The coarser coal passes through the whizzer and is discharged at a much lower velocity, with as much as 40 to 50 per cent reduction in wheel erosion.

The mills will also be arranged with center feed and a center auxiliary air supply, thus greatly eliminating trouble with sticking in the feed spouts when handling extremely wet coals.

The flues will be generally duplicate of No. 90. No recirculating fans will be installed but, instead, a by-pass duct will be installed around the air preheaters between forced draft fan discharge and the secondary air duct, in order to reduce corrosion on the preheater elements during low load periods.

The Ljungstrom air preheaters will be built with the top (cold end) two layers of preheater surface, 6 in. and 4 in. in depth respectively, of Cor-ten steel, wide spaced, and placed in baskets for quick removal and replacement in case of fouling. By increasing the spacing of the cold end lements, it has been found easier to keep them clean. In case of fouling, fouled baskets are removed and clean ones installed. The fouled baskets can then be washed and stored for future emergency use.

Each heater will be equipped with a single nozzle, motor driven reciprocating soot blower. Tests with the No. 90 pre-

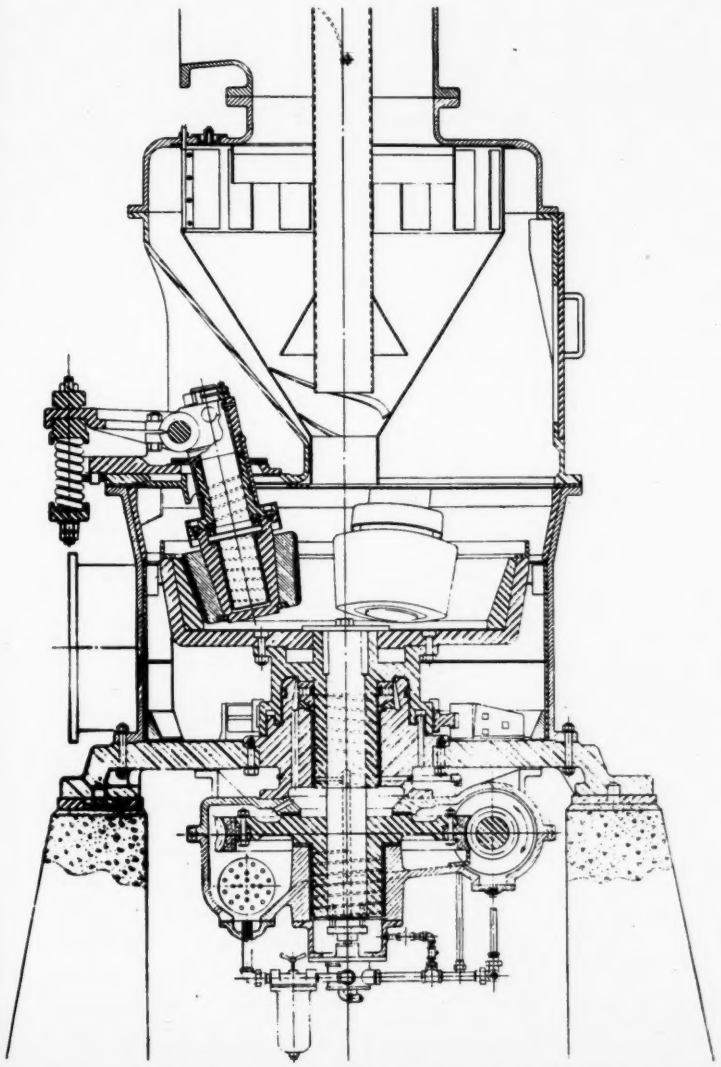


Fig. 3. Cross section of bowl mill for No. 100 unit showing center feed and flat bottom bowl

heaters have shown that no fouling occurs if the blowers are operated for a half hour per watch. Blowing is done six days per week at 300 psi and at 400 psi on the seventh day. These heaters have operated for ten months without any increase in draft loss. No other water washing will be used on the air heater elements.

The ash handling system was extended to serve the new boiler. As the need for stoker ash storage has become less, another bay of ash pocket has been utilized for fly ash storage. One of the existing receivers and bag filters was removed to discharge into the new bay, and a dustless unloader and belt conveyor for ash, similar to those existing, placed in this bay. All three dustless unloaders discharge to reversible belts so that the ash, conditioned to be dust-free can be unloaded either outboard to barges or inboard to trucks.

The induced draft fans are American Blower Company, No. 12 DI ½ DW Sirocco S-30, designed to handle 225,000 cfm of gas at 320 F and 15 in. static pressure. Each pair of fans is driven by a single impulse type turbine and direct connected reduction gear of the double helical type with double ended drive shaft. Turbine speed is 4910 rpm at maximum condition, ratio 8.05. Steam to the throttle is 200 lb abs at 485 F, exhausting at 18 lb abs.

The forced draft fans are American Blower Company, No. 10 DI standard DW HS type, each designed for 156,000 cfm at 15 in. static pressure. In the case of No. 100 boiler, air temperature is specified at 120 F instead of 80 F as in the case of No. 90 boiler. These fans are also driven by a single turbine of the impulse type with double helical type reduction gear employing G E quill type drive shafts. Turbine speed is 5640 rpm at maximum condition, ratio 4.6. Flexible couplings are special G E type. Steam to the throttle is 200 lb abs at 480 F, exhausting at 18 lb abs.

The coal bunker and existing Redler coal conveyor were altered so that the Redler would take coal from more bunker openings to serve the three additional mills. Scales were omitted in this installation. Downtakes are made with continuously expanding sections so that handling of wet coal can be done with less sticking.

This boiler, as well as the No. 90 boiler, is equipped with a control panel located in the boiler room basement upon which the temperature of the mill air is indicated, and from which the mill air temperature is controlled. Mill air temperature also registers and is recorded in the control room.

The control room is designed to accommodate a similar and opposite hand arrangement of the control benchboard and vertical panel, such as has been provided for No. 90. Combustion and feedwater controls generally duplicate the existing installation.

The sight gage system of No. 90 transmits the water level optically from both ends of the drum to the control board. This system has been amplified by a Yarway remote level indicator on Boiler No. 100.

In lighting off No. 90 boiler, it was found that the stack draft caused too high a suction in the furnace, irrespective of fan speed. A manually controlled damper at the outlet on the induced draft fans has been employed for draft control, but its position is such as to be inconvenient for operation. Both No. 90 and No. 100 will be equipped with power driven dampers, the controls of which are in the control room.

The new boiler has four burners per corner instead of three. To attain the additional burner, the piping from the mill serving the bottom burner has been sub-divided. This sub-division was made in order to attain a more intimate mixing of coal and air and lessen the tendency toward wall corrosion. The two bottom burners are adjustable vertically by hand wheels and the two top burners are adjustable vertically through pneumatic cylinder. All controls are local at each corner of the boiler.

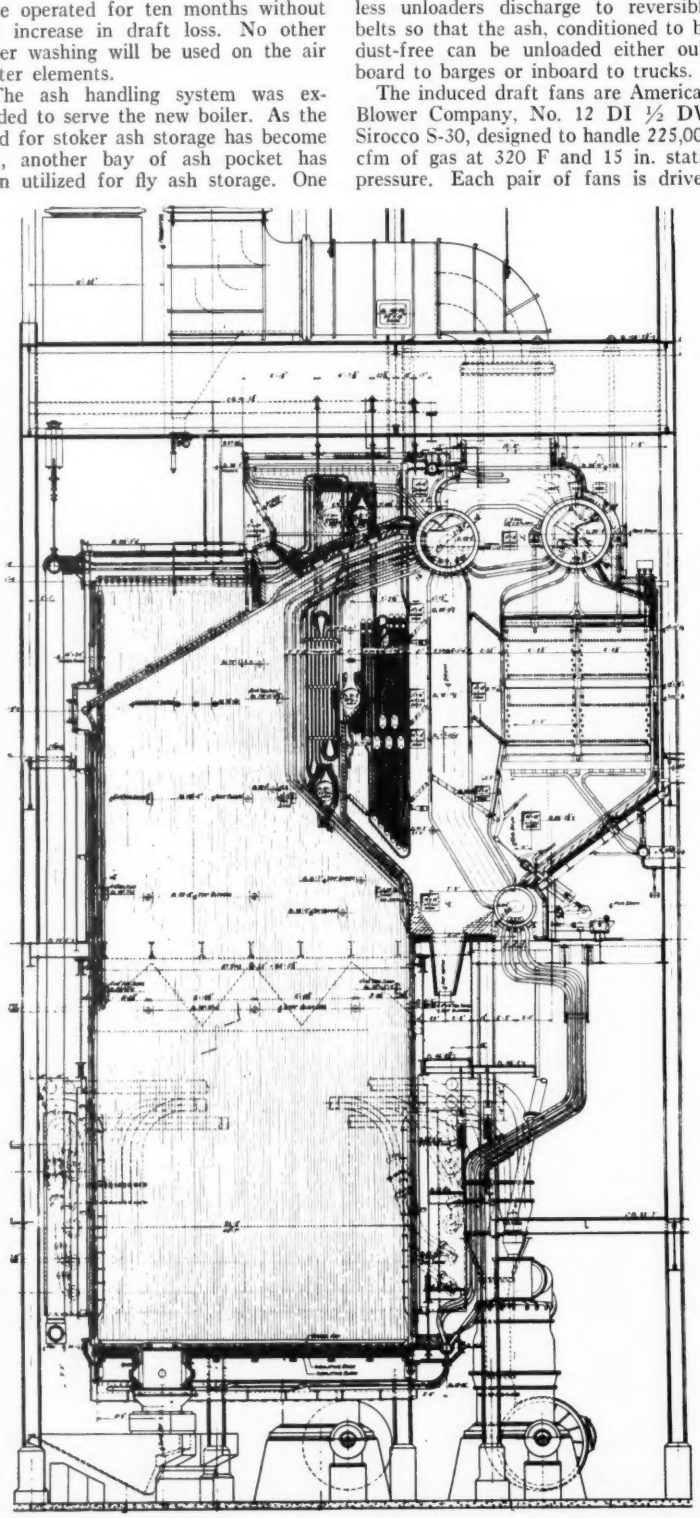


Fig. 2. Elevation of new steam generating unit. Note three rows of screen tubes in front of superheater

The burners of No. 90 boiler were equipped with automatic gas ignition torches for lighting off and warming up the unit. In order that the tremendous gas consumption of the station would not be increased by another gas ignited boiler, it was decided to utilize the oil storage, heating and pumping facilities of the station for ignition of the new boiler using either oil or gas tar. Eight steam atomizing ignition torches are capable of heating up the boiler in a minimum of time to the point where the turbine can be rolled and the boiler fired with pulverized coal. In addition, sixteen mechanical atomizing burners are provided, so that in case of coal

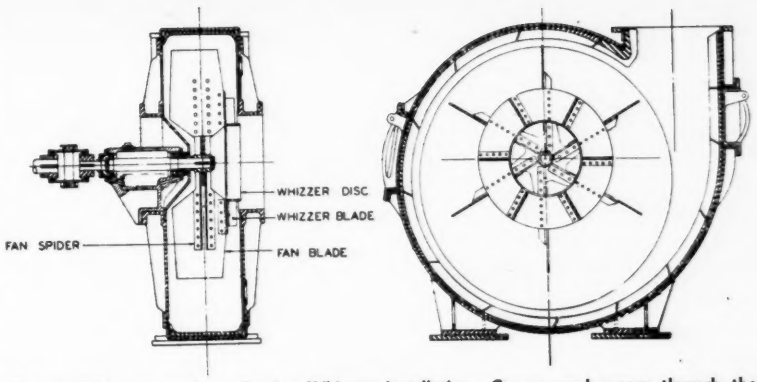


Fig. 4. Exhauster sections showing Whizzer installation. Coarser coal passes through the whizzer

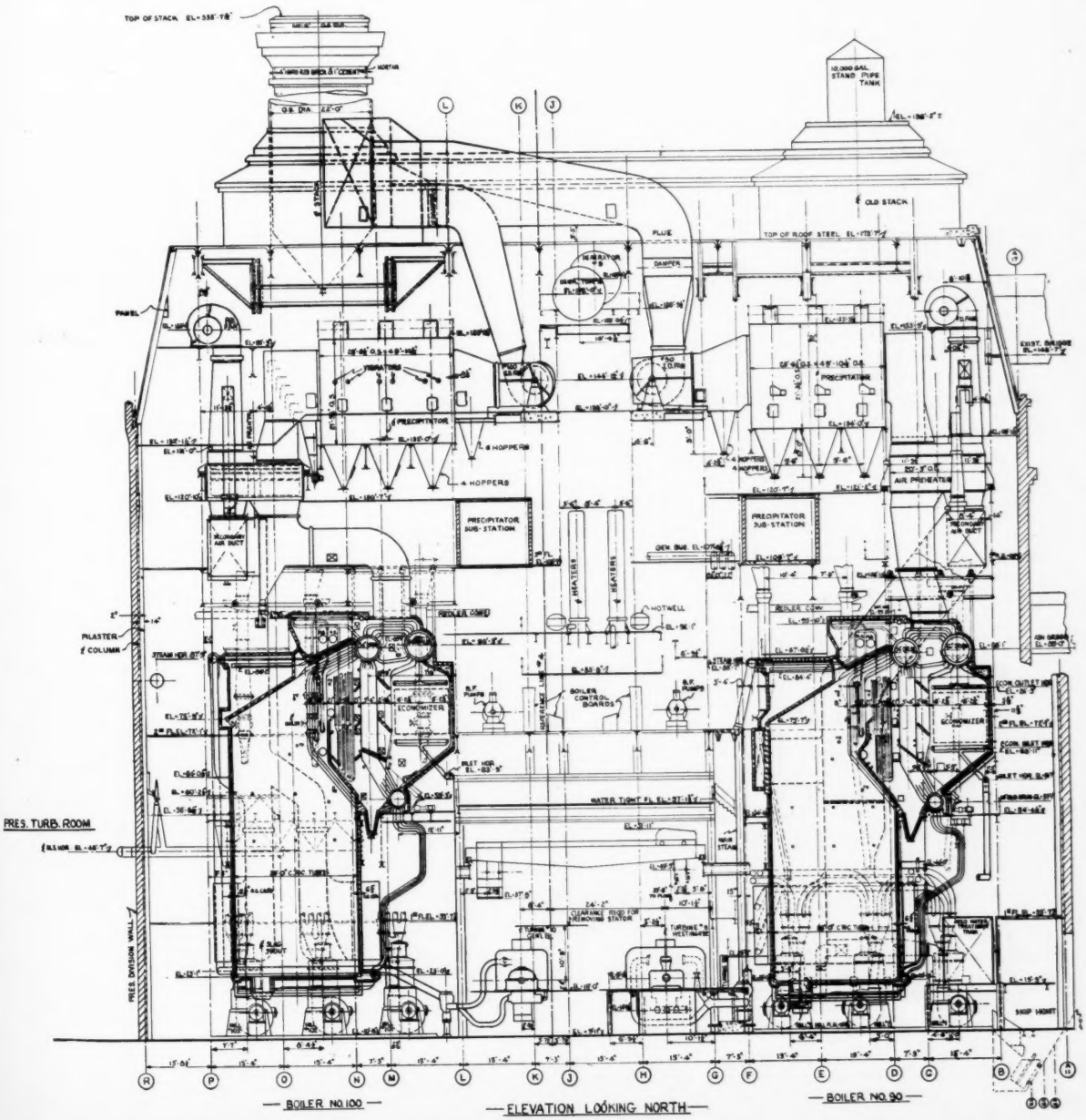


Fig. 1. Cross section through Sherman Creek Station, looking north. Both boilers face West, a change from the original plans

PRINCIPAL BOILER PLANT EQUIPMENT IN SHERMAN CREEK TOPPING UNIT NO. 100

Steam Generating Unit
1, Combustion Engineering Company, Inc., bent tube boiler, bifurcated, bare tube water walls, Elesco pendant type superheater, Elesco economizer, Ljungstrom air heaters; steam generating capacity 1,000,000 lb per hr, 1600 psi and 950 F; boiler 14,100 sq ft; water wall 10,995 sq ft; superheater 28,200 sq ft; economizer 33,960 sq ft; air heaters each 124,800 sq ft; furnace volume 53,700 cu ft; liberation 21,900 Btu per cu ft at 1,000,000 lb; tangentially fired, 4 burners per corner with oil ignition torches; 3 Raymond Bowl type mills each driven by a 300 hp G. E. Co. 900 rpm, 3 phase, 60 cycle, 2300 v motor.

Precipitator
1 Cottrell precipitator manufactured by Research Corporation designed for 95 per cent removal when handling 460,000 cfm gas at 340 F; three sections long, steel plate electrodes with 4 electrical sets operating at half wave on the first two sections, either full wave or half wave on last section.

Induced Draft Fans
2 American Blower Corporation No. 12 DI ½ DW Sirocco S-30; designed for 225,000 cfm of 320 F gas at 15 in. H_2O static pressure at 598 rpm.

Induced Draft Fan Drives
2 fans are driven by a single Westinghouse turbine with double ended driving shaft; turbine rating 1700 hp at 4700 rpm with 185 psi, 485 F steam, exhausting at 3 psi noncondensing; gear reduction double helical gear and pinion—ratio 8.06.

Forced Draft Fans
2 American Blower Corporation No. 10 DI DW high speed backward inclined blades; each designed for 156,000 cfm of 120 F air at 15 in. H_2O static pressure at 1227 rpm.

Forced Draft Fan Drives
2 fans driven by a single G. E. turbine with double ended driving shaft; turbine rating 946 hp at 5760 rpm with 180 psi, 485 F steam and exhausting at 3 psi; noncondensing-impulse type; gear ratio 4.7.

Soot Blowers
Diamond Power Specialty Corporation system consisting of retracting wall blowers, telescopic blowers at arch, superheater inlet and superheater bank and rotating elements in convection surface and economizer arranged to steam blow sequentially as controlled by air from a control panel.

Fly Ash Handling
Extension to existing United Conveyor pneumatic system with loading points at boiler, precipitator, flues and stack, discharging to ash pockets on wharf. Existing system consists of duplicate cyclone receivers and bag filters (1 set a spare), powered by G. E. Co. 75 hp, 1775 rpm, 3 phase, 60 cycle motors; remote automatic and manual control from separate control panel at boiler; capacity 7½ tons of ash per hour.

Fly Ash Conditioner
One new United Conveyor rotary ash conditioner installed in parallel with the existing two below the ash pockets; capacity each 25 tons dry ash per hour.

Conditioned Fly Ash Conveyors
One new Stephens Adamson Mfg. Co. 30 in. wide reversing belt conveyor installed in parallel with the existing two and arranged to move outward and discharge to scows or move inboard and discharge to trucks; 2 hp, 116 rpm, 3 phase, 60 cycle, 208 v totally enclosed dust tight, weatherproof motors; capacity each 50 tons per hour.

Coal Distributing Conveyor
One existing 15 in. wide pull Redler conveyor by Stephens Adamson Mfg. Co., 167 ft. long x 15 ft. 4 in. wide centers; rearranged to load at 6 additional points and discharge to three new and three existing mills; capacity 20 tons per hr; powered by two 7½ hp Westinghouse gear motors; motors 8.8 rpm, 60 cycle, 208 v, 3 phase located in diagonal corners in parallel.

Combustion Control
Republic Flow Meter arranged to regulate induced and forced draft fan turbine speeds and coal feed to maintain steam pressure.

Feedwater Control
Bailey Meter Company 3 element control on steam flow, water flow and water level varies speed of boiler feed pumps.

Control Bench Board and Panel
Light gray Formica covered plywood on structural steel work fabricated by Falstrom Co. Plywood fabrication, Formica application and shop assembly by Schvetz and Hadeler.

Blow Down System
Into existing Babcock & Wilcox Co. system consisting of 1 high and 1 low pressure flash tank in series designed to flash 150,000 lb blow down per hr.

Chemical Feed Pumps
Two Proportioneer duplex high pressure chemical feed pumps (1 spare) for phosphate and caustic; capacity range each cylinder 0.03 to 0.3 gpm at 2200 psi.

Feedwater Treatment
Make up from existing low pressure condensate system or from existing Permutit Company sodium-hydrogen Zeo-Karb softening system designed to soften 50,000 lb per hr of Croton water.

shortage, the full boiler evaporation can be obtained. In this event, the ignition is accomplished with the steam atomized torches, which are then replaced, one by one, with mechanical atomizing burners. This substitution can be made while the unit is operating, without change in load.

The oil supply valve is incorporated in the interlock system and closes with loss of either forced or induced draft fan pressure, in the same manner as the mills and feeders shut down when firing with coal.

The boiler takes its water from the existing system. Blowdown is into the existing blowdown tanks which were installed with boiler No. 90. Other boiler plant features remain practically the same as in the first installation.

The availability of first boiler in 1945 was 93 per cent. With these changes in design, it is felt that even more reliability is to be obtained from the new boiler. It is also felt that more ease of operation and less maintenance will be attained.

IMPORTANCE OF LABELLING

CONTAINERS of organic solvents should always be labeled, to avoid solvent accidents. These chemicals are generally colorless, often have a pleasant odor, and may therefore be mistaken for harmless liquids. In this way, unlabeled containers of solvents may lead to accidents as a result of ingestion or inhalation of the vapor. Moreover, the fire hazard of flammable solvents is not apparent unless clearly stated on the label.

Manufacturers of solvents, to prevent misuse of their products, use warning labels which indicate measures needed to assure safety. These labels have been developed by the Manufacturing Chemists Association and are published in its Manual L-2.

Drums or containers of solvents, if shipped directly from the manufacturer, are therefore usually correctly labeled when they arrive at the plant. Frequently, however, the drum is kept in some centrally located spot, from which cans or bottles are filled. If these smaller containers are not properly labeled, the user is left ignorant as to the nature of the liquid he is handling and injury to health or a fire may result.

For solvent safety, it is important that every container, whatever its size, carry a label duplicating the information on the original drum. When containers are refilled, labels should be compared to prevent refilling with the wrong solvent. Supervision by responsible plant personnel at the point of distribution is advisable, to make certain that these rules are carried out.—*Safety Research Institute.*

LOW-LOSS MAGNETIC MATERIALS

GRAIN-ORIENTED silicon-iron (Hipersil) has gone a long way since its introduction by Westinghouse about ten years ago. It was first employed in standard gages—about 14 mils—as core material for distribution and power transformers. In order to make the most of the favorable magnetic properties in the rolling direction (the permeability is about one third better than non-oriented silicon iron) all but the very large distribution transformer cores are wound, like adding machine tape, banded into a solid block, sawed in two for entry of the coils, and reassembled. The smaller cores permit smaller coils, which means less surrounding oil and tank.

The seemingly endless demand for communication transformers, particularly at the very high frequencies, even up to thousands of megacycles, called for thinner and thinner Hipersil, to hold the eddy-current losses within reason. Rolling and heat-treating techniques have been improved, successfully permitting production at practical cost of 7-mil, 5-mil, 3-mil, and now 2-mil Hipersil. Tens of thousands of transformer cores some of them as small as a single peanut, were made for communicating equipments. These thinner-gage Hipersil cores are continuing to be used for high-frequency service as for radar, television, and F-M radio where the service justifies the higher cost.

When the designer of a motor or other device requiring a soft magnetic material finds himself under pressure to decrease its size or weight he can consider Hiperco. Hiperco is a magnetic material high in cobalt. It can be forged, pressed, or rolled into desired shape. It has the fortunate property of permitting a higher flux density, obtained with a lower magnetizing force, than ordinary materials. In aircraft generators and motors, for example, it permits up to ten per cent overall induction size and weight. After annealing, Hiperco is somewhat more brittle than ordinary materials and hence requires care in assembling. At present at least, it costs more than conventional materials, hence its use is determined by the worth of the benefits it provides.

Annual Meeting of the ASME

By **RALPH E. TURNER**, Editor, **Power Plant Engineering**

Broadened interest of engineers in public affairs stressed at ASME meeting in New York . . . Research progress noted in many power engineering lines . . . Fuels and burning equipment received careful study . . . Methods of steam temperature control analyzed . . . Progress in prevention of boiler corrosion and embrittlement related . . . Problems encountered in application of gas turbines discussed . . . Attendance record broken

THE SIXTY-SEVENTH Annual Meeting of the American Society of Mechanical Engineers, with which was held the First National Convention of the American Rocket Society, built its program around "The Public Responsibility of the Engineer" as the keynote topic and broke all records for attendance, approximately 5000 total. All sessions were held in Hotel Pennsylvania in New York City, the meeting extending from December 2 to 6.

Very appropriately Congressman Carl Hinshaw of California, himself an engineer, was chosen to express his views on the theme of the meeting at the luncheon on the first day of the meeting. The world and the nation are at a critical junction in history, and the engineer, "that unique synthesis of the theoretical and the practical that is so badly needed" must accept his responsibility in public life and office, he told his audience.

Admonishing the engineer to use his vision combined with his practical knowledge of industry to bring the truth to those who would "chase after the rainbow to the left," he declared that we in America do not want the Soviet system which is "the economy of an enormous prison." The national economy is threatened by the vicious cycle which begins with the inciting of strikes and slow-downs as "instruments of destruction." Engineers, he thinks, should see service in city councils, state legislatures, congress of the United States and in positions of executive authority everywhere in the body politic of our country.

Among others who expressed themselves in a similar vein were Senator-elect Ralph Flanders, D. Robert Yarnall, president of ASME, Roy V. Wright, Harold V. Coes, Samuel M. Dean, Alex D. Bailey, E. E. Williams, Leonard J. Fletcher, and Paul G. Hoffman, all of whom have given eminent service in public affairs.

That engineers are giving more thought to the broad problems of citizenship and national economy was evidenced by lively interest taken in many sessions held under such headings as citizenship, education and training, commercial imagination, public responsibility, industrial accident prevention, ingenuity, management, national labor policy, and wages and productivity.

Fig. 1. Everybody happy in the procession to the dais for the annual Honors Night dinner of the ASME. Ernest Hartford, executive assistant secretary gives the marching orders. Left to right: Ernest Hartford, Troels Warming, Morris E. Leeds, Irving E. Moultrop, Lewis K. Sillcox, Alexander G. Christie, Sir Guy Garrod, D. Robert Yarnall, Eugene W. O'Brien, Air Commodore Frank Whittle, Theodore P. Wright, Group Captain R. J. Legg, Normal R. Gibson, George I. Rockwood

Essentially, however, the meeting was devoted principally to the detailed technical problems of the mechanical engineer and many of the papers presented were strictly in the power generating field, such for instance as fuels and burning equipment, boiler feedwater studies, gas turbines, oil and gas power, heat transfer, and properties of materials including graphitization. In many of these papers were reports of intensive research which has been made, pointing to future improvements in design and operation of equipment.

Space here does not permit of reviewing more than what seems to be the most outstanding highlights of the papers of direct interest to power plant engineers. Full benefit can only be had by study of entire papers a selected list of which is presented herewith for the convenience of readers. Copies of most of these can be secured from the secretary of the Society at nominal cost.

Horizontal Cyclone Burner

As a result of successful pilot-plant operation, a development installation of a horizontal cyclone burner was made at the Calumet Station of the Commonwealth Edison Co. of Chicago. This was an installation involving a steam-generating unit of 150,000 to 180,000 lb steam capacity per hr. The unit has been operating since September, 1944, during which time much experimental work has been done to improve the operating characteristics. The performance of this horizontal cyclone burner has definitely proved the principles involved to be sound, providing a simple, reliable, and efficient means of burning coals, particularly of the poorer grades having a high percentage of ash with low fusing temperature, according to a paper by A. E. Grunert, L. Skog and L. S. Wilcoxson.

Some years ago The Babcock & Wilcox Co. approached the problem of utilizing advantageously the generally considered undesirable characteristics of the ash in coal. It was felt that if the ash liberated from the coal upon combustion could be kept where it belonged, namely, in the furnace, one could not only effectively and efficiently use poorer grades of coal, but at the same time largely eliminate the slag-cleaning prob-

lem so prevalent with both stoker- and pulverized coal firing.

Furthermore, by increasing the rate of burning of the coal, the size of the furnaces necessary for a given capacity could be reduced. This would result in a reduction in the cost of making steam, which would be attributable to decreased capital expenditure for the equipment involved, as well as savings in its operation and maintenance.

To achieve the desired results, it was decided to employ the principles of a cyclone. If crushed coal is admitted tangentially to a cylindrical burner in a stream of air at a sufficiently high velocity, the particles of coal will be thrown to the surface of the cylinder and will be carried in the air stream along the wall of the cylinder in the form of an increasing-pitch helix until the energy of the entering stream of air has been dissipated.

If, in addition to the primary air, sufficient secondary air for complete combustion of the coal is admitted in a path parallel to the primary air and coal, and at a correspondingly high velocity, and if at the same time the temperature is sufficiently high to promote and maintain combustion, the volatile matter in the coal will first be distilled and burned; then the remaining carbon will be burned, and finally the ash will be left. Provided the fusing temperature of the ash is lower than the temperature obtained on combustion, it will be in a molten state as slag. The resulting slag, due to the energy in the stream of products of combustion, will be in contact with the surface of the burner, so that it becomes entirely coated with molten slag.

By inclining the axis of the cylindrical burner, the molten slag will drain toward its low point, from which it can be removed continuously. As this molten-slag surface of the burner is established, further crushed coal admitted with the primary air, on being thrown to the surface of the burner by the energy of the conveying air, will be caught by the slag. The movement of the slag on the surface of the burner, due to its viscosity, is very much less than the velocity of the entering air, and this provides an intense scrubbing action of the high-velocity air on the combustible of the coal particles entrapped and moving with the slower moving film of molten slag, with resulting extremely high combustion rates.

The conclusions reached as a result of the experimental work done on the horizontal cyclone burner are: 1. That the ash-handling problem in the burning of coal in public-utility and large industrial units is greatly simplified both as to equipment installed and labor requirements for its removal.

2. That the reduced quantity of fly ash in the gases discharged from the stack during normal operation requires, if anything, only a greatly simplified form of dust-separation equipment and obviates the necessity for costly equipment with its operating and maintenance expense.

3. That the discharge of relatively clean gases of combustion from the burner to the boiler unit permits rearrangement of heat-absorbing surface with substantial reduction of both equipment and labor for cleaning the absorbing surface.

4. That the rearrangement of heat-absorption surface as with item 3 results in a smaller unit for the same capacity when compared with other methods of combustion.

5. That the substitution of a lower first cost and lower operating- and maintenance-cost coal crusher represents a saving, as compared with the higher first cost, higher operating- and maintenance-cost pulverizers as used for pulverized-coal firing.

6. That the substantial reduction of slag and fly ash in the products of combustion leaving the burner and entering the heat-absorbing surface of the unit not only provides the advantages thus far enumerated, but by virtue of the elimination of the necessity for manual cleaning of the heat-absorbing surface, makes possible operation of the unit with the products of combustion under pressure, with possible elimination of the induced-draft fan with its attendant first cost, operating, and maintenance expense.

A comparison between cyclone-burner and pulverized-coal-fired high-pressure high-temperature steam-generating units for a new installation of 75,000 kw capacity shows the following advantages attributable to the cyclone burner:

1. A reduction in the floor area required of approximately 25 per cent.

2. A reduction in building volume of approximately 33 per cent.

3. A reduction in weight of approximately 22 per cent.

These anticipated reductions in building dimensions represent appreciable savings in cost, which, when combined with the other savings enumerated, collectively show an estimated saving in capital cost, from all sources, of from $6 to $6.50 per kw or about $500,000 for a 75,000-kw plant.

NEW ASME OFFICERS

President: Eugene W. O'Brien, vice-president of the W. R. C. Smith Publishing Co., of Atlanta, Ga. He succeeds R. Robert Yarnall. Regional vice presidents are: Professor Linn Helander, Manhattan, Kans.; Thomas S. McEwan, Chicago, Ill.; Albert R. Mumford, New York, N.Y.; Edward E. Williams, Charlotte, N.C.; and Alton C. Chick, Providence, R.I. Directors-at-large are: Frederick S. Blackall, Jr., Woonsocket, R.I.; Wilber A. Carter, Detroit, Mich.; and Lewis F. Moody, Princeton, N.J. Nevin Elwell Funk, Philadelphia, Pa., was named during the current meeting, as vice president of region III, to fill the vacancy created by the death of Alexander R. Stevenson, Schenectady, N.Y.

Application of Coal Burning Equipment

During a panel discussion conducted by the Fuels and Power Divisions several authorities described recent trends in the design and application of industrial steam generating units.

J. E. Tobey stated that new postwar

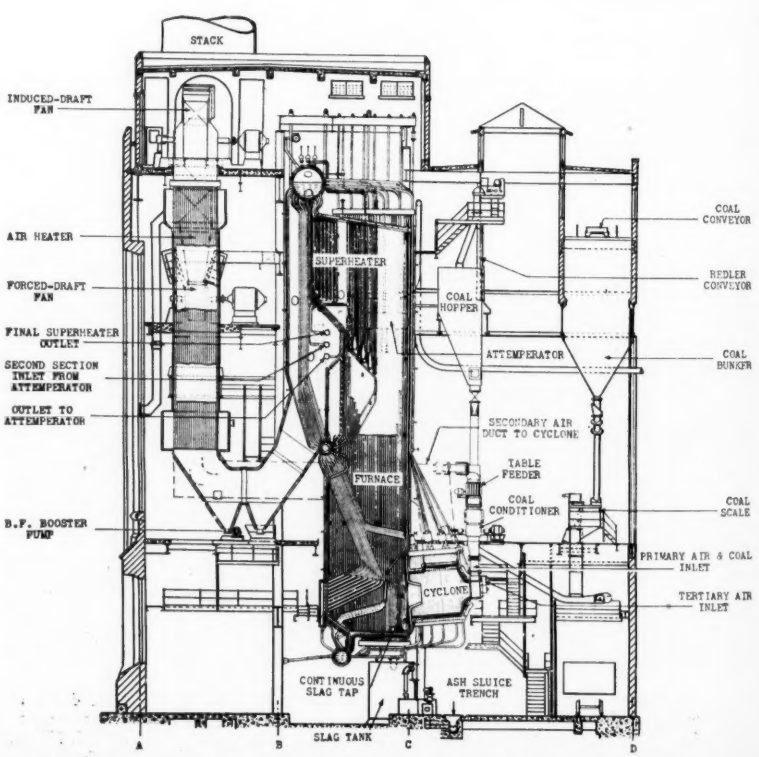


Fig. 2. Sectional side view of boiler unit No. 20-A, Calumet Station, Commonwealth Edison Co., Chicago, Ill., with horizontal-cyclone burner firing

LIST OF SELECTED PAPERS OF SPECIAL INTEREST TO POWER ENGINEERS

A Simplified Method for the Design of Vibration Isolating Suspensions, *Robert C. Lewis and Karl Unholtz.*

Horizontal Cyclone Burner.* *Arthur E. Grunert, Ludwig Skog, and Leslie S. Wilcoxson.*

Determination of Moisture Content of Coal by Means of Pulverizer Heat Balance. *T. J. Finnegan and H. L. Smith.* Determining moisture content of raw coal by means of heat required to dry it in pulverizer prior to delivery to burners of direct-fired pulverized coal installation.

Characteristic Coefficients of Butterfly Valves. *S. M. Dushkes.*

The Measurement of Rapidly Varying Flows of Gases and Liquids. *H. W. Stoll.* Discussion is restricted to designs using manometers of liquid type and those utilizing diaphragms and bellows, and is limited to streamline flow for which 1200 is assumed as a safe maximum value of Reynolds number.

Multiple Element Control Systems. *H. H. Gorrie.* Process operating limitations and process controllability are considered with respect to single-element and multiple-element control actions.

Practical Considerations Relating to the Use of Infrared Heating. *Paul H. Goodell.* Performance characteristics of large lamp banks.

Theory of Radiant Heating with Incandescent Lamps. *F. M. Tiller and Harold J. Garber.* Mathematical theory, consisting of a Fourier analysis, is presented, with supporting experimental evidence.

Control and Prediction of Pulsation Frequency in a Duct System. *W. R. Heath and W. R. Elliott.* Results of studies on compressor-duct systems which are unstable over portion of performance curves. Preventive methods are discussed.

A Note on the Damped Vibration Absorber. *John E. Brock.*

Corrosion-Erosion of Boiler-Feed Pumps and Regulating Valves.* *H. A. Wagner, J. M. Decker, and J. Canfield Marsh, III.*

Investigation of Acid Attack on Boilers and the Effect of Repeated Acid Cleaning on the Metal.* *H. C. Farmer.*

Model Tests of Granby Pumps. *Bruce L. VanderBoegh.* Tests of the contractor's model of the Granby pumps made at the Newport News Hydraulic Laboratory.

Hydro in Wartime Germany. *A. Hoefle.* The underwater-type turbine widely used in Germany is extensively treated.

Correction for Heat Conduction Through Longitudinal Baffle of Heat Exchanger. *A. M. Whistler.*

Shell-Side Coefficients of Heat Transfer in a Baffled Heat Exchanger. *H. S. Gardner and Irving Siller.*

Part Load Characteristics of Marine Gas Turbine Plants.* *W. M. Rohsenow and J. P. Hunsaker.*

Some Effects of Pressure Loss on the Open-Cycle Gas Turbine Power Plant.* *J. I. Yellott and Eric F. Lype.*

The National Fuel Reserves and Their Relation to the Future Supply of Liquid Fuels.* *A. C. Fieldner.*

Factors Rarely Considered in Smoke Abatement.* *H. F. Hebley.*

The Value of Wet Compression in Gas Turbine Cycles.* *R. V. Kleinschmidt.*

Gas Turbines With Water Injection.* *Carl A. Norman and Richard H. Zimmerman.*

Corrosion and Embrittlement of Boiler Metal at 1350 Lb Operating Pressure.* *L. E. Hankison and M. D. Baker.*

Experiences With Internal-Boiler-Surface Corrosion in 1450-Lb Open-Pass Boilers at West End Station of The Cincinnati Gas and Electric Co.* *E. H. Mitsch and B. J. Yeager.*

Wall-Tube Corrosion in Steam-Generating Equipment Operating Around 1300 psi.* *F. G. Straub.*

Studies on Susceptibility of Casting Steels to Graphitization. *J. J. Kanter.*

A Report on Graphitization Studies in Philadelphia Electric Company's High Temperature Welded Piping. *A. E. White and E. L. Hopping.*

Graphitization Studies of Materials for High Temperature Service in Steam Plants. *W. G. Conant and W. A. Reich.*

Progress Report on Pressurized Combustion of Pulverized Coal: Coal Preparation; Fly Ash Removal; and Introduction to Combustion. *J. I. Yellott and C. F. Kottcamp.* This paper analyzes problems encountered in using coal as gas-turbine fuel, under pressures of 50 to 75 psi.

Furnace Temperature Control for Large Steam Generating Units.* *Otto de Lorenzi.*

Recent Gas Turbine Developments. *Adolf Meyer.*

A 2000 hp Gas-Turbine Generator Set. *T. J. Putz.*

Abrupt Energy Transformations in Flowing Gases. *Neil P. Bailey.* After setting up basic equations of energy, flow, and acceleration this paper compares theoretical and actual plane compression shocks in tubes. Tests of combustion with flow in constant-area tube are given.

Coefficients of Discharge of Sharp-Edged Concentric Orifices in Commercial Two, Three and Four Inch Pipes for Low Reynolds Numbers Using Flange Taps. *L. K. Spink and Edgar E. Ambrosius.*

Orifice Discharge Coefficients in the Viscose Flow Range. *G. S. Peterson.* Results obtained from calibrating two orifice assembly units for use in measuring lubricating oil flow rates in aviation engines during flight.

Some Practical Applications of Flue-Gas Recirculation.* *W. H. Rowand and E. Durham.*

Clogging of Bituminous Coal in Bunkers. *R. F. Legget.*

Hydrogen Peroxide for Propulsive Power—Production and Use by the Germans During World War II. *Logan McKee.*

Steam Turbines for Main Propulsion of High-Powered Combatant Ships. *Glenn B. Warren.* Details of main turbines and auxiliary equipment used eventually to power main combatant vessels during the war are given. Future design and metallurgical possibilities are mentioned.

Continuation of the Joint EEI-AEIC Investigation on Graphitization of Piping. *S. L. Hoyt and A. M. Hall.*

Influence of Postweld Heat-Treatment on Graphitization. *I. A. Rohrig and Arthur McCutchan.* Laboratory test results to establish suitable time temperature relations for postweld heat-treatment to prevent graphitization of arc-welded joints in carbon-molybdenum and plain-carbon pipe steels.

Measurement of the Viscosity and Shear Elasticity of Liquids by Means of a Torsionally Vibrating Crystal. *W. P. Mason.*

Performance of Vertical Waterwheel Thrusting Bearings During the Starting Period. *C. M. Laffoon, R. A. Baudry and P. R. Heller.*

An Analysis of the Parallel Surface Thrust Bearing. *Milton C. Shaw.*

Corrosion Is No Accident. *H. E. Smith, Jr.* Graphic account of types of corrosion encountered on C-47 aircraft at Biak Air Depot, Netherlands, East Indies, and location on structure of planes. Inadequate maintenance by using organizations given as cause for widely prevalent condition.

Precipitation-Hardened Alloys for Gas-Turbine Service. *Howard Scott and R. B. Gordon.*

Materials for Power Gas Turbines. *C. T. Evans, Jr.* Materials used in construction of first Elliott Co. power gas turbine are described.

Nickel-Chromium Alloys for Gas-Turbine Service. *C. A. Crawford.*

Methods of Accident Control for Engineers. *H. W. Heinrich.*

* Paper briefed in accompanying text.

power plants reflect improved design with respect to fuel burning equipment. "The fact that bituminous coal is the basic fuel for steam generation," he said, "was conclusively demonstrated during the war, and the report of the U. S. Bureau of Mines that 98.8 per cent of the nation's known fuel reserves are in coal (particularly bituminous and subbituminous) should remove all doubt."

Equipment manufacturers today have the "know-how" to design fuel burning equipment for the satisfactory and efficient use of a wide range of coals.

He reported a study of the design data of a majority of the larger boiler units contracted for in 1945 and 1946 in 16 states comprising the entire Northeastern United States and the Great Lakes region. This area contains most of the nation's heavy industries. Also, included is one unit in Ontario, Canada.

Records including design data on 254 coal burning installations were made available for this study by 10 leading boiler manufacturers and several stoker companies. Not more than 20 per cent of these installations have been completed to date. The units considered include capacities from 1,000,000 lb of steam per hr down to 15,000 lb. No attempt was made to include smaller units, of which no doubt there were a large number purchased. The total steam generating capacity of the 254 units is approximately 35,000,000 lb of steam per hr, representing an average of about 140,000 lb per unit. It is estimated that the annual coal consumption of these units will be approximately 12,000,000 tons.

He reported that pulverizers and spreader stokers are the dominant methods of firing and account for 90 per cent of the number of units reported and 95 per cent of the total generating capacity. All units from 151,000 to 1,000,000 lb capacity were pulverizer fired. Both pulverizers and stokers were used in the 15,000 to 150,000 lb capacity range with spreader stokers accounting for 117 units; pulverizers, 69; traveling and chain grate stokers, 12; underfeed stokers, 13, out of a total of 211 units in this capacity range.

The designing of coal burning equipment to eliminate trouble spots was discussed by W. H. Rowand, who stated that during the war many units operated continuously for a year at a time at maximum load followed by one week's outage for maintenance and inspection, and on some units these periods were stretched to 18 months between outages.

Tests indicate that when the average true gas temperature leaving furnace exceeds the oxidizing initial deformation temperature of the ash, cleaning of ash from convection surfaces becomes excessive. The effect of the atmosphere on fusion characteristics of the ash helps to explain the great importance of providing sufficient excess air at the burners by minimizing air leakage, to insure efficient combustion under oxidizing conditions. The shielded high velocity thermocouple is proving a most valuable instrument for measuring furnace gas temperature. Case histories

were used to illustrate various arrangements of heating surfaces and burners which eliminate serious fouling.

Defining fuel economics as the movement of fuel from the ground to the consumer in response to demand, price, quality, availability and suitability, John Van Brunt stated that these terms include everything pertaining to fuel that affects its use and value to the consumer, and therefore determines the fuel best suited to produce steam at the lowest cost. He urged a thorough fuel survey before the plant is designed and type of equipment selected—recommended low furnace heat release and sufficient pulverizer capacity to grind a wide variety of coals—also sufficient preheat temperature to dry wettest coals.

"Purchasers, in buying equipment," said Ollison Craig, "should have their engineers specify in precise terms the things which are fundamental in obtaining equipment which will give the expected results. Such things as stoker grate area, rates of fuel burning per sq ft furnace volume, heat release per cu ft, amount and extent of water-cooling surface in the furnace should be definitely stated and manufacturers required to offer equipment which will meet these specifications.

"In making such specifications, it is vitally necessary to give thorough consideration, not only to the immediate requirements and the immediately available fuels, but to future requirements and the fuels which may be available then to meet these requirements."

Taking up the problem of better application of combustion equipment for small industrial plants, T. A. Marsh stated that "Combustion equipment and the engineering knowledge pertaining to its application are available to bring small plants to high standards of economy. Equipment should be proportioned with a safe margin above requirements for the most limiting coal, without exceeding critical combustion rates. Draft provision should be ample both as to static pressure and cfm. The furnace should be so designed in regard to the heat available per sq ft of black surface exposed that maximum ratings may be obtained without exceeding critical temperatures."

In reviewing the war time lessons in coal burning, Carl E. Miller, who had supervision over 3000 industrial type power plants operated by the U. S. Army in 1945, and which burned a variety of coals from every producing district in the U. S. and Alaska, suggested that personnel should be considered in the design and application of combustion equipment for small plants. Greater margins of capacity and flexibility should be incorporated to give good performance under various operating conditions and wide ranges of fuel supply.

"Future trends in the application of coal burning equipment may take the course of radical departure from current practice," said F. W. Argue, "but usually progress is made along evolutionary lines. It is expected that coal burning systems of the future will be more flexible as to coal selection, the various pieces of equipment will be better coordinated, and many of the present difficulties will be overcome."

In considering pulverized fuel for the gas turbine, Martin Frisch reviewed the effect of fineness on the capacity and size of pulverizing equipment with particular reference to proposed open cycle pulverized fuel fired gas turbine applications. The performance characteristics of mechanical and pneumatic pulverizers were compared, particularly for pressurized operation of the pulverizers for direct firing. Published results of tests on the German Anger air jet and Kollbohm steam jet mills and an American air jet and steam jet mill were analyzed."

"Jet mills appear to have a future in this field," he stated, "if they can be made to produce the required fineness with energy requirements comparable to those of mechanical pulverizers which, at present, require less than half the power."

National Fuel Reserves

As the coal miners' strike was still in effect at the time of this meeting great interest was shown in the paper presented by Arno. C. Fieldner on the nations fuel reserves and their relation to the future supply of liquid fuels. In calling attention to the good fortune of the nation in having large reserve of solid, liquid and gaseous fuels in natural forms, he stated that estimates place reserves of coal and lignite in the United States, not including Alaska, at 3.2 trillion net tons which is thought to be 40 to 50 per cent of the entire world's coal of all ranks. Petroleum reserves in the United States are estimated at 20.8 billion barrels, about 35 per cent of the proved world reserves, and natural gas reserve have been estimated at not less than 135 trillion cu ft, no reliable figure being available for the world supply. No estimate of our national energy resources, he thinks can be complete without considering fissionable material, but information is not now available on national reserves of uranium and thorium.

In addition to the natural liquid fuels, he pointed out that a broad survey of other sources of liquid fuels indicates that petroleum may be supplemented by (1) alcohols from the fermentation of vegetable matter, (2) conversion of natural gas by the gas-synthesis process, (3) distillation of oil shale, (4) liquification of coal or lignite by the high-pressure hydrogenation process and (5) conversion of water gas from coal or lignite by the gas-synthesis process.

The reserves of solid, liquid and gaseous fuels of the nation combined have energy equivalent to 2.6 trillion tons of bituminous coal with a heat value of 13,000 Btu per lb. Coal and lignite comprise 98.8 per cent of this energy reserve. With process now developed, all reserves of solid fuels can be used to supplement declining reserves of natural gas and petroleum for many years, certainly, he states, "not less than 1000 yr and probably for 2000 yr."

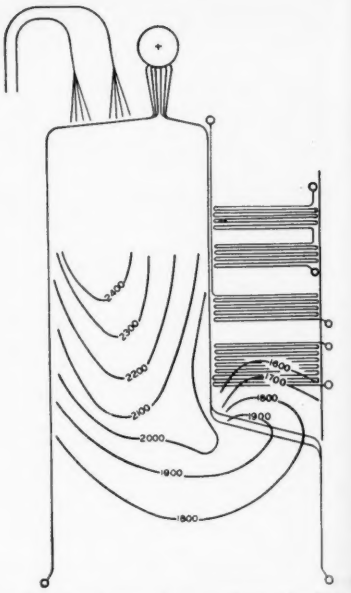


Fig. 3. Gas temperature contours by high-velocity thermocouple test of furnace in Connecticut Power Co. plant at Stamford Station. One of case studies presented by W. H. Rowand

Smoke Abatement

Dozens of large and small cities, according to Henry F. Hebley, have, since the close of the war, returned to demands for effective smoke abatement. Although outlining the usual pattern adopted by cities to reduce atmospheric pollution, his particular attention was given to the factors that are rarely considered by those writing the laws. His review of the problems involved brought him to the conclusion that it is desirable that the modern climatologist, skilled in the new techniques developed during the last five years, become closely associated with the planning and execution of any investigation involving the variable influence of weather, and its effects on air pollution.

Legislation and agitation of public sentiment will fail, Mr. Hebley thinks, unless smoke abatement is based on results of a painstaking and unemotional research. Some of the questions which need to be answered are: What shall be considered as atmospheic pollution? What quality of pollution is present in a city's atmosphere? Where was that pollution produced: locally or by outside sources? When was that pollution produced? What percentage came from industry? Commerce? Domestic? What distance does pollution travel? What is the variation of pollution with time—that is, by years, by seasons, by days, and by hours? What quantitative measures can be adopted? What practical measure can be adopted to reduce air pollution both by prevention and removal?

To help in the solution of the problems he suggested co-operative efforts of combustion engineers, climatologists, doctors, economists, statistical experts, and chemists:

Fig. 4. Norman R. Gibson, vice-president and director of the Buffalo Niagara Electric Corp. (left) receives the Holley Medal being presented by ASME president D. Robert Yarnall, president of Yarnall Waring Co.

Furniture Temperature Control

In the opinion of Otto DeLorenzi, as expressed in his paper Furnace Temperature Control for Large Steam Generating Units, the ability to adjust the furnace outlet temperature of large steam generating units enables the operator to maintain a uniform superheated steam temperature over a wider range of capacity than is possible with any other present available means.

The amount of superheater surface and its location in a given steam generating unit, he reported, is usually fixed by the steam temperature required at some specific capacity and by the fuel used. The performance of this superheater at capacity points other than that for which it is designed, will depend upon the temperature and the mass flow of the gas sweeping over its surface, the temperature of the feedwater, the cleanliness of the furnace heat absorbing surfaces and the output at which the unit is operated.

The contour of the temperature capacity curve is fixed and it can only be shifted bodily upward or downward by changing either the amount of gas which flows over the superheater or the entering gas temperature. The change in gas flow may be secured through some form of by-pass arrangement. The temperature change can be accomplished by increasing or decreasing the amount of heat absorbing surface which is used to screen the superheater.

Included in the paper were the results of a series of tests which the author has conducted with various methods of controlling furnace temperature by means of baffling. He stated that the demand for constant steam temperature at superheater outlet over a wide range of capacity, presents a serious design problem. It is one in which temperature of the products of combustion leaving the furnace must be sufficiently high to effect the necessary heat transfer, yet avoid deposition of slag on the heat absorbing surfaces. If the gas temperature is high enough at partial load to obtain full superheat, then at full load it may be too high to avoid slagging. Furthermore, wide fluctuations and divergence in steam temperature are almost wholly due to changes in gas temperature, resulting from variations in furnace operating conditions.

A logical approach, he said, to overcome these difficulties must provide for maintaining favorable operating conditions in a direct and positive manner. With the design employed, it must be possible quickly to adjust the temperature of gas flowing over the superheater to secure desired steam temperature. It must also be possible selectively to make a relative change in furnace volume and areas of heat absorbing surface.

It was reported that these requirements are met through positioning the zone of turbulent combustion in the furnace cavity and thereby apparently modify the heat liberation rate, and correspondingly change the effectiveness of the furnace heat absorbing surface to produce the temperature at furnace outlet which results in the desired degree of superheat. A by-pass damper is used as a means of final incremental adjustment of steam temperature.

These requirements, he states, can best be accomplished in tangentially-fired furnaces because the radiation and convection transfer, due to sweeping action of the envelope over the wall surface, is greater than with any other method of firing. The results of his tests demonstrated conclusively that furnace outlet temperature may be selectively controlled over a range of over some 200 F from maximum continuous load to some very low-load point. This temperature change is secured manually through a conveniently placed push-button control, which causes the burners to be tilted either upward or downward as may be required. It thus becomes possible, at all times, to operate the furnace of a steam-generating unit, equipped with tilting burners, under conditions which avoid slag accumulations on the heating surface, and yet produce constant superheated steam temperature over a wider range in capacity than by any other direct means now available.

Flue Gas Recirculation

One of the special features of the Neches Butane Products Co. plant located at Port Neches, Texas, is the use of flue gas recirculation to temper the gases of combustion ahead of separately-fired superheaters. This feature of the plant was made the subject of a paper for the meeting by W. H. Rowand and E. Durham.

In reviewing this practice it was stated that the temperature of the gases from direct combustion with normal excess air is ordinarily too high for direct application to heat exchangers, in which the heat absorbing medium is steam or gas, unless tremendously high mass flows with their costly pressure losses or expensive alloys or both are resorted to. Gas recirculation reduces the temperatures of the gases entering the heat exchanger to the point where sensible design conditions may be safely projected into actual operation, carried out with reasonable care and under simple control limitations.

Where the efficiency of the unit is unimportant, the products of combustion may be cooled by admitting air to the gases before they enter the heat exchanger. If instead of air a portion of the relatively cool gases leaving the heat exchanger is recirculated to the furnace and mixed with the products of combustion, the advantages of the reduced gas temperatures entering the exchanger may be obtained without an appreciable loss of efficiency. By proper control of the recirculated gases:

1. A lower furnace temperature is maintained which results in lower furnace maintenance.

2. The gas temperature entering the heat exchanger is sufficiently low to permit control of metal temperatures.

3. In spite of the reduction in heat transfer desired and accomplished at the entrance to the heat exchanger, the average absorption is decreased very little because of the higher mass flow of the gases.

4. The gas weight to the stack or supplementary heat transfer equipment is that corresponding to the low excess

air required for efficient combustion which results in a minimum stack loss.

5. The gases used for recirculation will have sufficient sensible heat removed from them to permit efficient handling by a fan, and easy introduction through simple ports and dampers.

6. Some additional work will be expended by the fan required for recirculating the gases.

The authors report that experience has shown that flue gas recirculation is a practical and efficient application for the tempering of combustion gases before entering heat exchange equipment provided effective mixing of the gases is obtained by careful design. With the trend toward the use of increased temperature for process and power purposes, its use should continue to increase steadily.

Flue gas recirculation has many applications. As was pointed out in the paper, it is excellently suited for separately-fired superheaters and air heaters. It is applicable also to special process equipment such as benzene superheaters in the plastic industry, and for oil heaters in the petroleum industry. In the power field where space conditions prevent the use of sufficient radiant heat absorbing surface to cool the gases below the fusion point of the ash, flue gas recirculation may be used to cool the gases and prevent slagging trouble. Flue gas recirculation may play an important part in certain types of gas turbine applications, in the opinion of the authors.

Coal Clogging in Bunkers

Due to the impeded flow of bituminous coal out of the reinforced concrete bunkers of the Polymer Corporation's steam power plant at Sarnia, Ontario, R. F. Legget carried on extensive study of the problem through a series of tests in a model bunker, and described his research work in a paper before the Society. His final conclusion was that the clogging was determined by the moisture content of the coal, and he suggested ways of controlling the moisture content below the critical value. It was reported that much of the trouble with clogging was eliminated when the methods of reclaiming were changed.

Boiler Feed Pump Corrosion-Erosion

At the Marysville Power Plant of the Detroit Edison Co., seven 500-hr corrosion-erosion tests involving a total of 18 different materials were conducted and the results of this investigation were reported in a paper by H. A. Wagner, J. M. Decker and J. C. Marsh. The tests were designed to determine the resistance of materials to the corrosion-erosion type of attack experienced in boiler feed pumps and regulating valves.

Two of these tests were for the purpose of verifying the pressure differential used. The other five tests indicated that resistance to corrosion-erosion is materially increased by using chromium-bearing alloy steels. Bronzes and monel are resistant to attack, and to a lesser extent, so is cast iron. Results obtained with a bakelite-lacquer-coated carbon-steel specimen indicated that this coating has considerable promise for use with present boiler-feed pumps having cast-carbon steel casings. The test used is of an accelerated type intended to simulate conditions in actual pumps and valves.

Regarding the determination of underlying causes of corrosion-erosion attack and means of alleviating it, it is not clear which of the variables is most important. It would appear, however, that high values of dissolved oxygen resulting from air leaks may have an important bearing on the problem. Comparison of the results of the tests described with results of tests underway or contemplated by other utilities may aid in the solution of this phase of the problem.

Acid Attack on Boilers

Reporting on an investigation of an acid attack on boilers and the effect of repeated acid cleaning on the metal, H. C. Farmer, chief chemist of the Philadelphia Electric Co., reported that the results of this investigation have served to clarify some of the controlling factors of acid attack which were not generally recognized.

The investigation showed that stressed metal is more readily attacked by inhibited acid than stress-relieved metal. With a knowledge of the controlling factors, such as temperatures, acid strength, and contact time, the operator can acid clean boilers with a reasonable assurance that corrosion or metal attack will be reduced to a minimum, according to the author's conclusions.

During the last few years the acid method of cleaning boilers has been more generally employed and it would seem logical that if any detrimental effects as a result of this treatment could be expected it should manifest itself in cases where the boilers had been acid cleaned several times.

It is also quite possible that acid attack may have occurred the first time that the boiler was cleaned, however, since no critical examination of the boiler may have been made prior to the acid treatment, it has often been assumed that any evidence of attack (when a more critical examination was made after acid cleaning) was presumed to have existed prior to acid cleaning, and as such was discounted. There are some cases on record which seem to indicate that boiler metal had been pitted and covered with deposits and that when the acid was first used these deposits were removed and the pitting exposed.

It is apparent, the author states, that an attack by inhibited acid can take place on stressed metal at temperatures below 175 F and that in order to minimize this attack, the boiler and solvent temperature should be reduced so as not to exceed 140 F. In order to insure that no hot spots exist in the boiler to be cleaned, the boiler should be cooled down and then preheated with hot water not higher than 160 F. When the boiler metal shows that the metal temperature is in the vicinity of 140 F, the acid solution should be introduced at 140 F.

The laboratory life tests made in the presence of boiler deposits containing copper and some ferric as well as some ferrous iron, presents a general picture of corrosion or metal loss which might be expected from the normal operation of acid cleaning a boiler every year. The data obtained indicate that a boiler could be acid cleaned 25 times without serious loss of metal.

Boiler Metal Corrosion and Embrittlement

At the Springdale Station of the West Penn Power Co., three 1350-psi boilers developed a peculiar type of metal attack after 7 yr of operation. These conditions caused considerable apprehension regarding the safety and continuous operating ability of these boilers which gave rise to an investigation of the trouble and steps taken to correct it. This investigation was reported in a paper by L. E. Hankinson and M. D. Baker, who described a type of barnacle corrosion and metal embrittlement under the corrosion that was experienced in the three boilers during the winter of 1944 and 1945.

Various other troubles such as circulation and contamination have previously been experienced and have been described in earlier papers before the Society, but the type of corrosion found when a piece of tube metal about 1 in. in diameter was blown from a boiler tube of No. 2 furnace was new to Springdale experience.

A section of tube that was thinned externally and had heavy barnacle corrosion inside was capped at each end and was given a hydrostatic pressure test to failure. The tube ruptured at 7400 psi. It was then sectioned through the rupture and pickled to remove the barnacle, after which it was flat ground to show the section. Examination by deep etching of a section of the tube where a barnacle had been, showed that the metal immediately under the barnacle was of a porous nature and embrittled. The embrittled metal is quite susceptible to attack by hot acid and deep-etching plainly showed the differ-

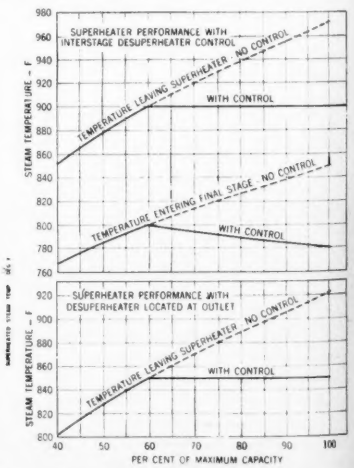
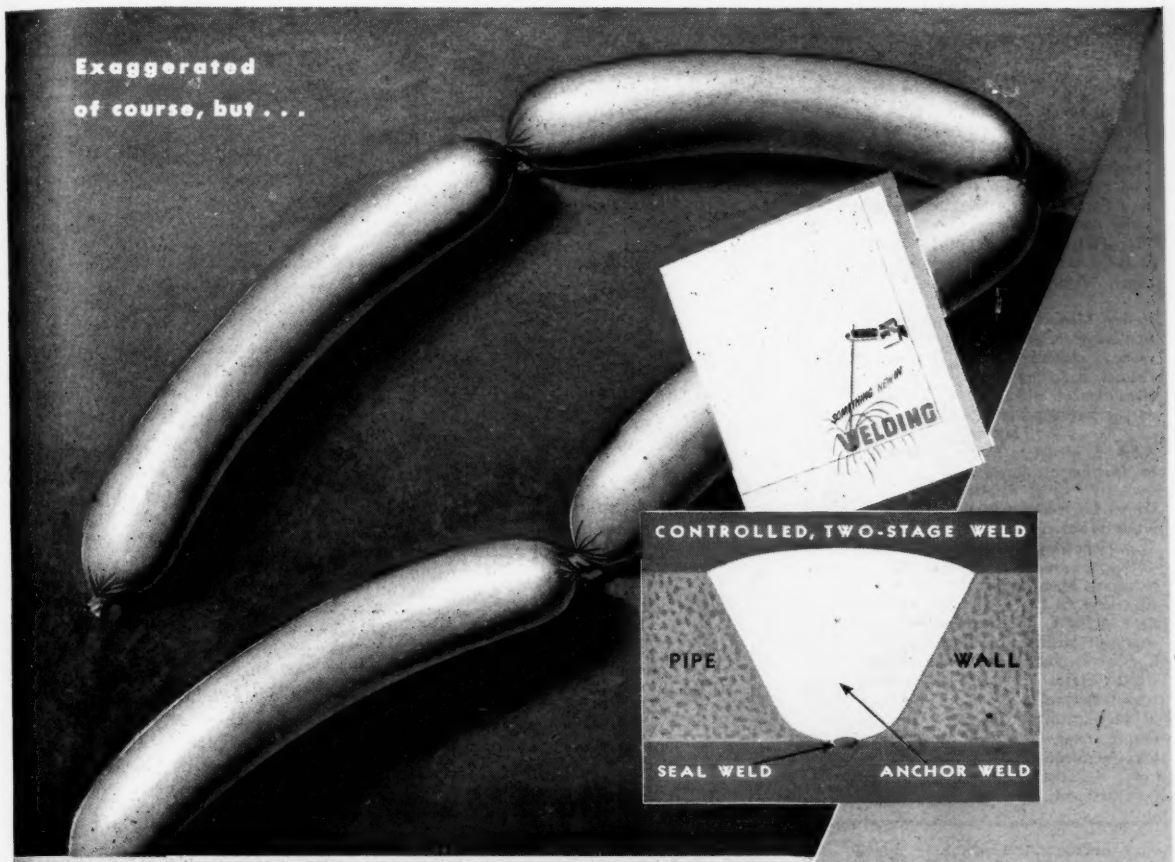


Fig. 5. Superheater performance without and with furnace temperature control discussed by Otto deLorenzi



Do Your Welded Pipe Lines have HOT DOG-LIKE Joints?

Obviously not . . . but just as obviously, backing rings at fusion butt welded joints constrict the inside diameter of the line in a manner reminiscent of a string of hot dogs. And, if backing rings are not used, icicle-like protrusions of weld metal result which, likewise, constrict the pipeline I.D. at the joints. . . . The patented Westport Method of Controlled, Two-Stage Welding produces an almost imperceptible joint, smoother on the inside than you ever saw on the outside of a butt weld . . . and this is obtained with maximum bondage and strength. . . . Our bulletin "Something New in Welding" tells the complete story. Write for it today. And remember, while our shop pre-fabricated piping can be made with any type of joint, we believe you'll prefer and specify the Westport, after you read our bulletin.

WESTPORT JOINT

(PATENTED)

Write for Bulletin
Something New in Welding

W. K. MITCHELL & CO., INC.
2942 ELLSWORTH STREET
PHILADELPHIA 46, PA.
SINCE 1899

MITCHELL

PIPING FABRICATORS AND CONTRACTORS

RECIPIENTS OF HONORS AND AWARDS

Undergraduate Student Award to Paul A. Thompson, for his paper, "Synthetic Sapphire —A New Industrial Engineering Material." Charles T. Main Award to Victor S. Rykwalder for his paper, "Creative Engineering as a Factor in Promoting Full Employment." Junior Award to Martin Goland, for his paper, "The Flutter of a Uniform Cantilever Wing." Melville Medal to Troels Warming, for his paper, "Polar Diagram for Tuning of Exhaust Pipes."

Holley Medal to Norman R. Gibson, "For Achievements and inventions which have advanced sciences of hydraulics and hydromechanics, including an original method of water measurement which made possible more accurate testing of large hydroelectric generating units."

A.S.M.E. Medal to Morris E. Leeds, "Pioneer in Instrument Development and Industrial Relations."

Daniel Guggenheim Medal to Air Commodore Frank Whittle, Royal Air Force, Great Britain, "For Pioneering the development of turbo-jet propulsion of aircraft."

Honorary Memberships to:
Alexander G. Christie, Fellow and Past-President, A.S.M.E., Professor of Mechanical Engineering, The Johns Hopkins University; Ralph E. Flanders, Fellow and Past-President, ASME, United States Senator from Vermont; Lieutenant General William S. Knudsen, Member of the Board of Directors, General Motors Corp.; Irving E. Moultrop, Fellow and Past Vice-President, ASME, Consulting Engineer; Lewis K. Sillcox, Fellow, ASME, First Vice-President, New York Air Brake Co.

ence between the original and the embrittled metal. The hydrogen weakened metal is fully three-quarters of the thickness of the metal that remained under the barnacle. It was evident that hydrogen attack had progressed more than half way through the tube under the barnacle while only one-fourth inch away the metal that was not under the barnacle was ductile and presumably in its original condition.

A study of some of the smaller barnacles showed that hydrogen attack or embrittlement had not developed under them. This is supposed to be due to their small area and the ease with which the hydrogen evolved was able to escape with the steam that was generated. A study of the juncture of one of these small barnacles to the tube metal, throws light on their formation and process of development. It seems as though the products of the corrosive action are always being pushed away from the parent metal and this action under the conditions of temperature and pressure allows the development of crystalline structure. The disintegration at the layer boundaries allows the barnacle to separate from the tube metal or from other layers of the barnacle.

To correct the condition, the dissolved oxygen content of the feedwater has been reduced to 0.02 ppm or below. Second, sulfite is maintained at 3 to 10 ppm in the boiler water. Third, the ammonia content of the feedwater has been reduced which has lowered the amount of copper compounds in the boiler sludge. Barnacle development and metal embrittlement have thus now been stopped. This is evidenced by 1½ yr of continuous operation of the deteriorated boiler metal without appreciable trouble.

Internal-Boiler-Surface Corrosion

Operating experiences with internal boiler surface corrosion in three 1450 lb open-pass boilers at the West End Station of the Cincinnati Gas & Electric Co., were described by E. H. Mitsch and B. J. Yeager. The three boilers under discussion in this paper were designed for 350,000 lb per hr maximum capacity. Number 5-1 has been operating in the station since April 1937, 5-2 since November, 1937, and 5-3 since March, 1938. It was reported that a pit type of corrosion in certain tubes of boiler 5-1 occurred in April, 1940, after 3 yr of operation without difficulty from corrosion. In February, 1941, the first failure by corrosion at the rolled joints of tubes occurred on boiler 5-3. This type of corrosion stopped being active at about the beginning of 1942 and had not recurred up to June, 1946. The rolled-joint corrosion appeared to occur during the period when the boilers were operated with continuous and rapid changes in steam demand. Conditions of operation, boiler-water concentration and other factors were described and compared in order to determine the cause of the corrosion or to determine what factors were responsible for arresting it.

In order to improve operating conditions the following things were done.

a. Heaters were vented; April 1940.

b. Drips from first stage of vacuum jets discharged to waste to reduce ammonia; November 1941.

c. Throttle extraction line on boiler-feed-pump turbine to increase exhaust pressure; April 1940.

d. Improved seals on 13-stage-heater drain pumps; April, 1940.

e. Added extensions on discharge lines from distilled-water tanks to prevent excess iron-corrosion deposits from being carried into the discharge from the bottom of the tanks; January 1942.

f. Began feeding NaOH to distilled water storage to increase akalinity of feedwater to boilers and through piping system; August 1942.

g. Installed manually operated makeup lines in the condensers to feed 5000 lb per hr, each to a spray head installed in the steam space; August 1942. Special internal-contact heaters had been installed in each condenser hotwell since 1937. Makeup water enters these heaters through 4-in. float-operated control valves.

The authors report that the fact that rolled-joint corrosion was found on tubes, where the tube-end protecting blocks were gone, indicates the importance of keeping such areas protected. The added heat at the unprotected ends is apparently a factor in the corrosion of rolled joints.

Water Tube Corrosion

Several instances of boiler-tube failures of the "brittle type" and the nonbrittle, were described by F. G. Straub, who stated that in the brittle type the metal is decarburized under the corrosion products on the water side. Intercrystalline cracks occur in the decarburized areas. His experience indicates that this type of failure may be due to the presence of dissolved oxygen in the feedwater in the absence of a suitable oxygen scavenger in the boiler water.

The nonbrittle type of corrosion de-

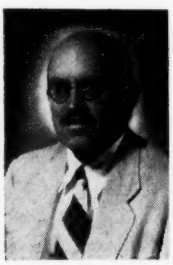
HONORED AT ASME ANNUAL DINNER

Martin Goland
Junior Award

Troels Warming
Melville Medal

Morris E. Leeds
ASME Medal

Alexander G. Christie
Honorary Membership



Ralph E. Flanders
Honorary Membership

Paul A. Thompson
Undergraduate Student Award

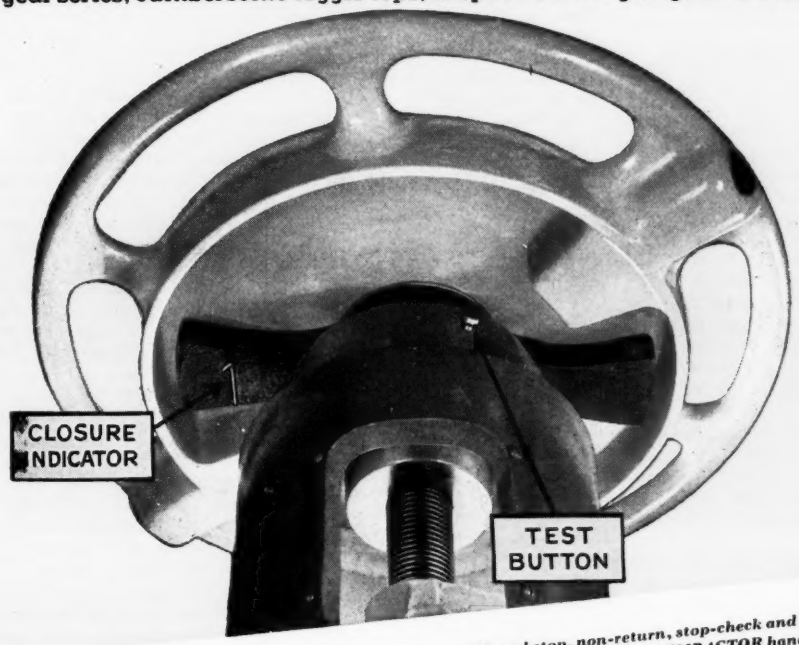
Victor S. Rykwalder
Charles T. Main Award

AN EDWARD CONTRIBUTION TO BETTER VALVE PERFORMANCE—THE IMPACTOR HANDWHEEL

How the *Edward* Impactor Handwheel closes big valves in little spaces

Where great torque is necessary to close a valve against high pressures —particularly in cramped areas— no operating device is as effective as the Edward IMPACTOR handwheel.

The IMPACTOR handwheel, an exclusive and patented Edward development, sees to it that a valve shuts tight against extreme pressures without extension levers, gear series, cumbersome toggle tops, or space-stealing large diameter wheels.



Notice—

- **how the two heavy lugs, cast integrally with the wheel at 180°, strike simultaneous hammer-blows on the cross arm attached to the stem —making a positive shut-off.**
- **ample strength for any operating emergency.**
- **closure indicator and test button.**
- **how simple and well balanced the whole mechanism is, how little space it takes up. Edward IMPACTOR equipped valves, in most sizes, also have Edward patented EValthrust yoke bushing for additional thrust capacity and smooth operation.**

Edward stop, non-return, stop-check and gate valves are regularly furnished with IMPACTOR handwheels, in the following sizes and pressures:

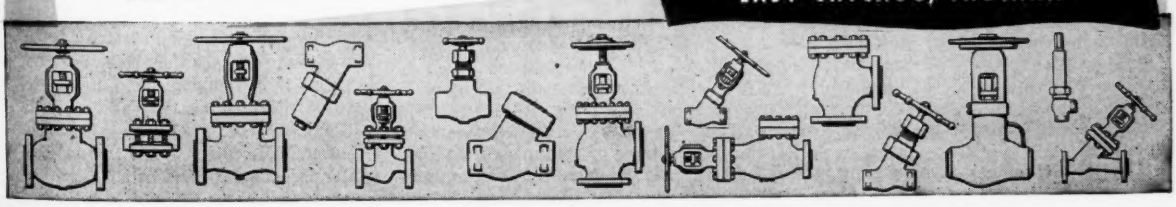
5 in. and larger 1500 lb; 6 in. and larger 900 lb; 8 in. and larger 600 lb; 10 in. and larger 300 lb.

ROCKWELL MANUFACTURING COMPANY E V

Edward Valves, Inc.

Subsidiary of Rockwell Manufacturing Company

EAST CHICAGO, INDIANA



scribed was due to caustic attack on the tube metal. The grain structure was normal in this type of corrosion and no intercrystalline cracking occurred. These types of failures have been stopped by proper water treatment, he reported.

Load Characteristics of Gas Turbine

The gas turbine has shown bright prospects of becoming an important source of prime power for many diverse applications such as marine, industrial, transportation, and air-craft power, according to W. M. Rohsenow and J. P. Hunsaker, in a paper devoted to Part Load Characteristics of Marine Gas Turbine Plants.

To be successful as a prime mover it was stated a gas turbine plant must have good part load characteristics and efficiencies. There are a number of cycle arrangements and methods of control that are of interest. In the investigation reported, the part load performance of two cycle arrangements were studied and the best method of control for a given set of operating conditions were indicated.

The simple gas turbine plant which was one of the cycles considered, consists of a compressor, combustion chamber, turbine and regenerator with the turbine and compressor on one shaft. A variation of this cycle is the use of dual turbines, one to drive the compressor and one to supply useful power. For the dual turbine cycle, either one or two combustion chambers may be used. If the combustion temperatures of each combustion chamber are equal, the two arrangements of the cycle have the same temperature-entropy diagram, but have different part load characteristics.

It was reported that with constant speed operation of the single turbine plant, no practical nor mechanical difficulties are encountered over the entire load range from zero to 100 per cent, except for large temperature variations which would accompany rapid load changes.

In dual turbine plant operation, the authors caution that a part load efficiency curve may be flattened at the expense of design point efficiency by staggering the design points of the component machines. That is, the turbine design point (maximum efficiency point) may be placed at the cycle's 80 per cent load point, while the compressor design point is at the cycle's full load point. This lowers the full load cycle efficiency by raising the 80 per cent load cycle efficiency thus flattening the efficiency curve slightly.

Pressure Loss in Gas Turbine Power Plant

In discussing the effects of pressure loss in the open cycle gas turbine plant, John I. Yellott and Eric Lype pointed out that the open cycle gas turbine has been analyzed in many recent publications. It was stated that most of these analyses, while they utilize probable values of turbine and compressor efficiencies, omit the effects of the pressure drops which occur in the actual components.

In the actual gas turbine plant, the pressure loss which occurs between the compressor and the turbine can seriously affect the performance of the cycle. This pressure loss will be particularly important when bituminous coal is used as the fuel, because of the necessity of interposing ash removal equipment between the combustor and the turbine. The study presented by the authors was undertaken in order to determine how much pressure loss can be tolerated in the ash eliminator and how seriously the cycle efficiency would be affected by the presence of such equipment.

The authors stated that the mathematical method outlined in their paper was chosen because a general solution was desired which would be applicable to higher values of turbine temperatures and regenerator effectiveness, when such values can be attained. The results of their investigation were presented in both tabular form and in a series of graphs. The authors conclude that the pressure loss is costly both in fuel consumption and in unit size. The higher pressure ratios needed to achieve optimum efficiency also requires higher rotative speeds and hence higher stresses in the turbine.

Wet Compression in Gas Turbine Cycles

Consideration was given by R. V. Kleinschmidt to the value of wet compression in gas turbine cycles. A major characteristic of the gas turbine, he explained, is that it has a high back-work ratio. The term back-work ratio is the ratio of the total mechanical work which is absorbed by compressors and other equipment necessary to the operation of the cycle, divided by the total work generated by all turbines or other prime movers in the cycle.

The author indicated that important improvements can be made by any means which will reduce the back-work ratio of the gas turbine cycle. One obvious way which has been used is to intercool the compressor in one or more stages. It seems a bit ridiculous to remove heat from the fluid which is then immediately to be subjected to additional heating. An effect similar to but better than intercooling can be obtained without actually removing heat from the cycle, the author stated, by compressing a mixture of finely divided liquid water suspended in air. The heat of compression of the air is absorbed as latent heat in the water which is evaporated.

At low compression ratios such as are now used in gas turbine cycles, the amount of water required is of the same order of magnitude as the weight of the fuel used in the cycle, 2 or 3 per cent of weight of air. This process referred to as wet compression reduces the work done by the compressor in much the same way as intercooling does but returns the heat removed from the air to the working fluid in the form of additional steam. The net result, according to the author, is a reduction in work of compression of 10 to 15 per cent and an increase of 5 to 10 per cent in the total volume of compressed working fluid which is delivered by the compressor. In the opinion of Mr. Kleinschmidt the improvements in gas turbine operation to be expected from wet compression are so great that a special study of wet compression in other types of compressors is indicated.

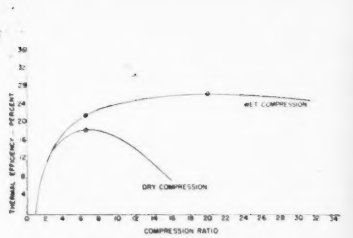


Fig. 7. Efficiency of Brayton cycle for compressing air. Air at 1200 F at gas turbine inlet, 70 F suction temperature, 85 per cent machine efficiencies. Curves presented by R. V. Kleinschmidt

In another paper dealing with a similar subject, Richard H. Zimmerman and C. A. Norman stated that the two main stumbling blocks in the way of continuous combustion gas turbine development have been the small margin between the net work of the turbine and the gross work required by the compressor; and the limit to maximum temperatures set by available materials.

Years ago it was suggested that water injection might solve both of these problems. Water injection in the combustion chamber was a very effective means for lowering the maximum temperature and water injection furnished a working medium which did not have to go through the compressor.

It was stated that water injection, of course, represents a loss of fuel heat to latent heat of evaporation of water; yet, with maximum temperatures of 1600 F and below, over-all thermal efficiencies will be decidedly improved with turbine and compressor efficiencies of 75 per cent or less.

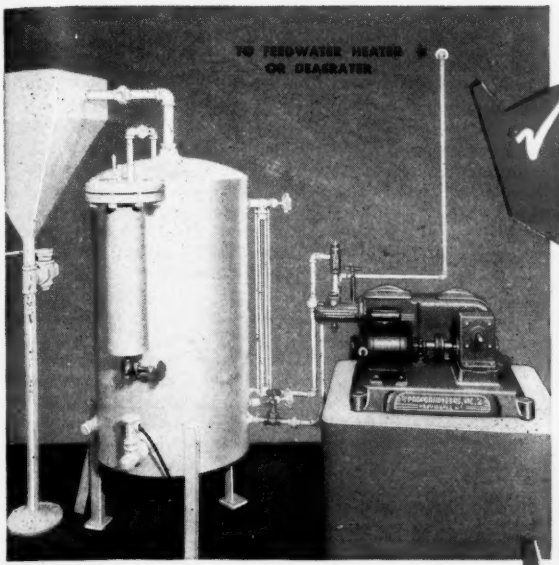
According to the authors' calculations, it was indicated that with a turbine efficiency of 85 per cent and a compressor efficiency of 65 per cent, the thermal efficiency with water injection of 14 per cent could be secured, while with a turbine efficiency of 65 per cent and a compressor efficiency of 85 per cent the thermal efficiency is only 11 per cent. In other words with water injection it is more important to improve the turbine efficiency than the compressor efficiency, at least for the comparatively low combustion chamber temperature of 1200 F.

Most striking are the data presented by the authors which show the gain in net work obtainable by water injection. It is in this connection that water injection shines; and it does so all the way up to combustion chamber temperature of 2000 F, at least when the air excess is low. With low combustion chamber temperatures and with efficiencies around 75 per cent the net work is more than doubled. And the aggregate is rendered operative and produces a notable net output even at temperatures and efficiencies so low that without water injection it would stall.

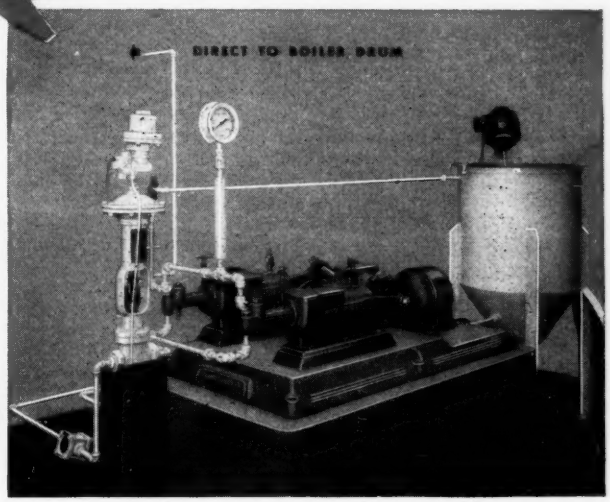
%PROPORTIONEERS%

Double Check TREATING EQUIPMENT

Protects Boilers • Reduces Maintenance Costs • Improves Heat Transmission



✓Checks oxygen in feedwater
CONSTANT RATE SODIUM SULPHITE FEED TO THE DEAERATER OR FEEDWATER HEATER



✓Checks corrosion and scale
CONTINUOUS OR INTERMITTENT PHOSPHATE FEED DIRECT TO THE BOILER DRUM

%PROPORTIONEERS, INC.% has standardized equipment and methods for time or flow responsive control, including special dissolving tanks, alarm systems, relief valves, automatic feeding and flushing valves, control panels, etc., to maintain top efficiency in power plant operation. We will gladly supply complete specifications.

% PROPORTIONEERS, INC. %

WRITE TO %PROPORTIONEERS, INC.%, 46 CODDING ST., PROVIDENCE 1, R. I.

Technical service representatives in principal cities of the United States, Canada and Mexico.

Raw and Treated Water in TVA Hydroelectric Plants

By **H. J. PETERSEN,** Head Mechanical Engineer, Tennessee Valley Authority

RAW WATER is used in the Authority's plants for cooling water for the main generators, for the air compressors, and for the air-conditioning equipment, and in some plants for fire protection, for lubricating the turbine-guide bearing, and for supplying make-up for the treated-water system.

In the low-head plants water is taken from the scroll case of each unit and pumped through a multiple basket strainer having 3/16-in. openings to a header leading to the station system. One pump is located at each unit to insure a positive cooling-water supply, and a standby pump is installed in the service bay of each plant. This latter pump is connected to the forebay by a separate intake and can supply any unit with cooling water in an emergency. All the pumps are connected into a header running the length of the powerhouse so that the chances of any one unit being without cooling water are remote.

The pumps are horizontally split-case, double-suction, single-stage, volute-type centrifugal units. Specifications include enclosed bronze impeller with wearing rings, bronze shaft sleeves through the stuffing box, water-seal piping, and deep stuffing boxes. Experience has proved that this type of pump will give years of service with little maintenance except occasional repacking or lubrication of the bearings. A booster pump is installed in each plant service system using raw water where the forebay pressure is insufficient for a gravity supply. Sometimes the operating requirements of two or more of these systems make it possible to supply them with water from one pump. Quantities involved are usually low and single-stage single-suction pumps are used. The Authority has found the close-coupled type of pump very satisfactory for this service.

In the high-head plants a separate intake from each unit pen-stock is connected to a central manifold from which the individual systems are supplied, with pressure-reducing valves installed as required. An air-cushion chamber is installed on the manifold to absorb the water hammer caused by the operation of the system. When the raw-water system supplies the make-up for the treated-water system, intakes at different levels are provided in the dam to enable the operator to take advantage of the varying water temperatures, turbidities, and chemical contents of the lake water at different levels.

The Authority uses black-steel pipe for exposed raw-water piping, except that galvanized steel is sometimes used in the smaller sizes. Welded joints are used, except that flanged joints are used around equipment and valves. Gaskets are 1/16-in. red rubber. Raw-water lines buried in the ground are cast iron, bell and spigot, in accordance with standard waterworks practice. Black wrought-iron pipe is used for buried lines in sizes 1½-in. and smaller, for sprinkler and general yard service.

Lines are insulated in locations where sweating of the cold pipe would prove objectionable. Standard commercial insulating felt molded in 3-ft. lengths and covered with 8-oz canvas jacket is used for straight runs of pipe. Fittings and irregular surfaces are covered with a layer of hair felt sealed with a waterproof-tape wrapping and a coating of asphaltic sealing compound. Insulation of 1 in. thickness has been found sufficient to prevent sweating for the water temperatures and air humidities encountered in the low-head hydro plants, but 1½-in. of insulation is necessary in the high-head plants because of the colder water. Regranulated cork has been used in some instances to prevent sweating, but unless it is applied very carefully and built up to a thickness of ¼-in. or more, it is not as satisfactory as hair felt. This is especially true in the high-head plants where water temperatures sometimes go as low as 36 F. Raw-water lines subject to freezing temperatures are insulated with built-up hair felt. The required thickness is a function of the temperatures encountered and the amount of water passing through the line and is investigated for each condition.

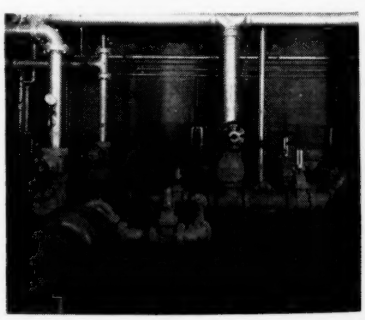
Treated Water

Treated water is used in the various hydro plants for all sanitary services, and in some plants for fire protection. Whenever possible the Authority obtains its treated water from a nearby community, even if this involves laying a mile or two of transmission main. We have found it to be more economical to purchase water in this manner than to install a treating system in the plant, requiring the services of an operator. However, it has been necessary to install water-treating systems in most of the projects because of their isolated locations.

At some projects the plant operators live close at hand and use water from the system. This increases the required capacity to the point where a conventional rapid sand-gravity filter plant, with mixing chamber, coagulation basin, dry-chemical feeders, and chlorinator is justified. The water treated in this area is such that alum and soda ash or lime are the reagents used. At some of the projects the demand is 10 gpm or less, and pressure filter plants are installed. Originally, pot feeders actuated by differential flow across the orifices were installed for chemical feeding in the pressure filter plants, but our experience with them has not been satisfactory, and they have been replaced with solution-feeder pumps. Pot feeders are difficult to keep regulated, especially when the temperature of the water supply varies considerably as it does with intermittent use.

System pressure is obtained by using elevated storage tanks which usually are transferred from the construction activities at the project. At some of the high-head plants, where such a tank was not available and where raw water for fire protection could be obtained from pond storage, a pneumatic tank was installed for the treated-water system pressure. However, the controls for these tanks require a great deal of attention to keep them in proper working order, and an elevated storage tank is much preferred.

The foregoing comments for pumps, piping, and insulation of the raw-water system apply to the treated-water system also except that in the latter case more galvanized-steel pipe is used.



Pumps for station service, fire, emergency generator cooling water in a TVA plant

From a paper entitled Design of Mechanical Auxiliaries for TVA Hydroelectric Plants, presented before Spring Meeting, ASME, Chattanooga, Tenn., April 1946. To be published in full in ASME Transactions.

Two Simple Inventions Offer Important Economies In Condenser Operation

New Fiberclad* Flowrite tube inserts stop condenser tube end erosion, seal tube leaks, prolong life of old tubes, and reduce water friction up to 80%.

New Detectaleak* Tube Tester instantly locates leaking tubes without necessity of dismantling condenser.

*PATENT PENDING

FOR over 20 years millions of Flowrites, metal belled-end tube inserts, have been used successfully to protect condenser tube inlet ends against erosion and to eliminate expensive shutdowns for tube replacement. A new type insert, called Fibreclad Flowrite, offers many important advantages over other types previously available.

The Fibreclad Flowrite consists of a belled-end unbreakable metal tube, similar to the old Flowrite, with a very thin fibre sleeve shrunk on the outside, as shown in Fig. 2. Installation is very simple, and requires no cement, no special care. After installation, the fibre swells when in contact with water, producing a very tight seal which prevents leakage, even through tubes eroded like those shown in Fig. 1.

The peculiar shape of Fibreclad Flowrites provides a perfect venturi which reduces water friction up to 80%, according to tests conducted at M. I. T.

Fiberclad Flowrites are available for any size tube, in lengths to suit the erosion problem of the particular unit for which they are ordered.

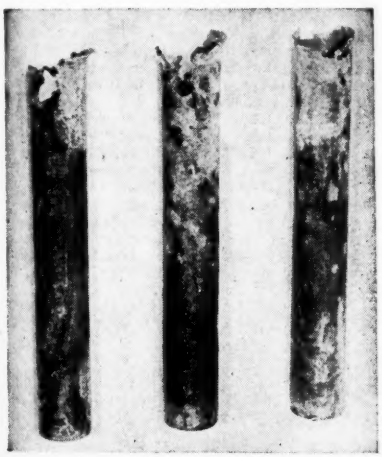


Fig. 1—Three badly eroded condenser tubes cut out of a unit to show condition of tubes which Fibreclad Flowrites can salvage for further service

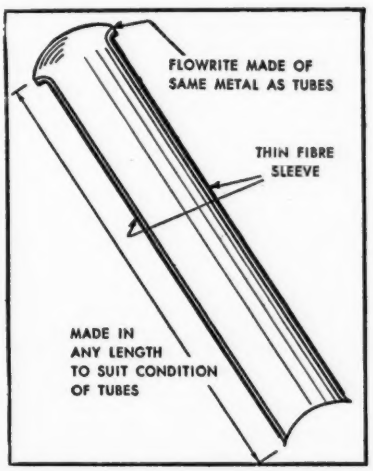


Fig. 2—Cross section of Fibreclad Flowrite showing new fibre sleeve feature

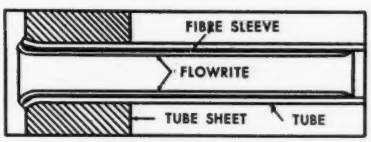


Fig. 3—Fibreclad Flowrites can be used with any type of tube joint

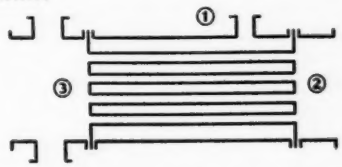
Detectaleak Tube Tester

Anyone who has gone through the tedious, time-consuming process of weeding out leaking condenser tubes will appreciate a newly invented simple tool called Detectaleak Tube Tester. With this tool leaking tubes can be located instantly without dismantling the condenser.

The Detectaleak Tube Tester consists of a rubber body, one end of which is conical to fit into the tube, and the other end is a thin-walled bulb. An air passage connects the bulb with the conical end. A knurled metal sleeve surrounds the body to provide a grip for the hand.

Fig. 4—Detectaleak Tube Tester which instantly indicates a leaking condenser tube

The illustrations show the simple, effective operation of the Detectaleak Tube Tester.

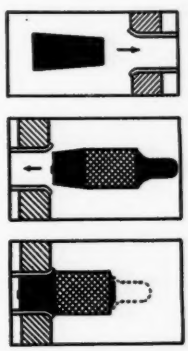


1—With condenser out of service, maintain vacuum in steam space with condenser steam jets.

2—Plug one end of tubes with fibre plugs.

3—Insert Detectaleak Tube Testers in other end of tubes.

4—If Detectaleak bulb is sucked in, tube leaks. Each penetrated tube is located quickly, positively.



The service crew of Condenser Service & Engineering Co., Inc., will conduct tests when you take your condenser out of service over the weekend, or any other time. The Detectaleak Tube Tester is one of many special tools developed by us to save time and labor. You can enjoy the fast, economical service of our highly-trained specialists any time of day or night, anywhere on the continent. All necessary materials are in stock. A wire or phone call will get your job started at once.

For complete details of Fibreclad Flowrites and Detectaleak Tube Testers write, wire or phone

CONDENSER SERVICE & ENGINEERING CO., INC., 69 River Street, HOBOKEN, N. J.

Designers and Manufacturers of

Chemical Processing Equipment
Steam Boilers
Steam Condensers
Steam Jet Air Ejectors
Evaporators
Stage Heaters
Gas Coolers
Drain Coolers and Heaters
Aftercoolers
Air Preheaters
Fuel Oil Heaters
Jacket Water Coolers
Process Heat Exchangers
Transformer Oil Coolers
Generator Air Coolers
Lubricating Oil Coolers
Storage Tank Oil Heaters
Feed Water Heaters
Distillers
Filters
Industrial and Oil Refinery Heat Exchangers
And other types of heat exchange equipment

NEWS from THE FIELD

STRIKE LOSSES IN STEEL TOP 12,350,000 TONS

DURING THE WEEK of December 1 the coal miners' strike caused the loss of enough steel to make 3,550,000 household refrigerators or 200,000 automobiles, the American Iron and Steel Institute estimated recently. The week's loss of 504,000 tons of ingot steel means a 350,000 ton drop in finished steel shipments to consumers in the near future. It raises the total loss of finished steel thus far this year due to strikes up to 12,350,000 tons, or almost three full months' shipments at recent rates.

Despite the effect of various strikes in reducing the available supply of steel, the steel industry is continuing to ship its limited output as equitably as possible, the Institute reports. In fact, first half of 1946 shipments of finished steel by the industry largely on a voluntary basis compared favorably with the 1941 distribution pattern when record prewar production was achieved of numerous durable goods, such as washing machines, refrigerators, trucks, and many other items.

In the first half of 1946, practically all the major groups using steel received a larger ratio of total shipments, than they did in 1941. Among those receiving a larger share of steel were automotive industry, container manufacturers, jobbers, dealers and distributors, steel converters and processors, makers of machinery, industrial equipment and tools, manufacturers of electrical machinery and equipment, builders of railroad equipment, the branches of the pressing, forming and stamping industry making consumer durable products, and various agricultural users.

AWARDS PRESENTED AT AWS ANNUAL MEETING

THE 1945-46 Samuel Wylie Miller Memorial Medal, the prizes of the Resistance Welder Manufacturers Association, the 1946 Lincoln Gold Medal, and the 1946 A. F. Davis Undergraduate Welding Awards, were presented at the annual banquet of the American Welding Society at its 27th Annual meeting, Ambassador Hotel, November 21.

Award of the Samuel Wylie Miller Memorial Medal was made to James F. Lincoln, president of The Lincoln Electric Co., Cleveland. Julius Heuschkel, Research Engineer, Westinghouse Research Laboratories, East Pittsburgh, Pa., was awarded the $750 first prize in the 1946 Resistance Welder Manufacturer's Association Prize Contest. This award was made for Mr. Heuschkel's paper entitled, "Selecting Spot Welding Schedules for Low Carbon Steels."

Joseph J. Riley, Sales Engineer, Taylor-Winfield Corp., received the second prize of $500 for his paper on "Vibration of Spot Welds in Low Carbon Steel Over A Range of Welding Variables."

The third award of $250 went to Robert W. Bennett and Robert D. Williams, authors of the paper entitled, "The Flash Welding of Hard Drawn Carbon Steel Wire."

MISSOURI MINES SCHOOL CELEBRATES 75TH YEAR

AN ACADEMIC convocation commemorating the Seventy-Fifth Anniversary of the Missouri School of Mines and Metallurgy was held recently in Rolla, Mo. Dr. Frederick A. Middlebush, President of the University of Missouri, presided at the convocation, and Dr. Eugene McAuliffe, Chairman, Board of Trustees, Union Pacific Coal, delivered the principal address on "The Engineer's Contribution to Society and the World."

Since the formal opening of the Missouri School of Mines and Metallurgy on "Dedication Day," November 23, 1871, the school has expanded from an institution with one building, two faculty members, and 28 students, to a modern school of technology valued at more than $3,000,000, having more than 100 faculty members and an enrollment of approximately 2200. Established and maintained jointly by the State of Missouri and the Federal Government under the provisions of the Morrill Act of 1862, the Missouri School of Mines and Metallurgy has provided technical and scientific education to more than 10,000 students coming from every state in America and many foreign countries.

URUGUAY HONORS WESTINGHOUSE OFFICIAL

PROF. SEGISMUNDO GERSZONOWICZ, Director of the Electrical Engineering Institute of the University of Montevideo, conferred the honorary degree of Doctor Honoris Causa upon William E. Knox, President of the Westinghouse Electric International Co., in a recent ceremony in New York City.

Introduction of American production methods in countries now trying to regain or establish a going industrial economy is the most valuable single thing the United States can do to promote international amity and understanding, and to raise the world's standard of living, according to Professor Gerszonowicz.

He pointed out that his country is leaning heavily on the technical and material assistance of such companies as Westinghouse in establishing its power industry. He cited the role Westinghouse has played in the development of the huge Rione hydro-electric project for the production of electrical power; the $35,000,000 Rio Negro power plant; and the aid Westinghouse has given toward the training of Uraguayan electrical engineers, through its assistance to the University's electrical engineering institute.

In response, Mr. Knox said that international friendship must be supported realistically and practically on a basis of mutual benefit. Both friendship and self-interest demand that we put our dollars and our technical skill to work helping other countries to industrialize themselves. It is his hope that this practical view, basis of the Westinghouse foreign trade policy for many years, will be adopted by other American business and industries in a national effort to make American technology the foundation of a new world prosperity and understanding.

BCR ADDS GARVEY TO DEVELOPMENT STAFF

BITUMINOUS COAL RESEARCH, INC., Pittsburgh, has announced that James R. Garvey, former captain in the U. S. Army Air Corps, has been added to its development engineering staff to expedite production and home testing of BCR Smokeless Stoves. He assumed his new duties in the Pittsburgh Office, where he will be associated with Dr. Harold J. Rose, vice president and director of research; Elmer R. Kaiser, assistant to president and assistant director of research; T. A. Day, special representative; William S. Major, development engineer; and Carl S. Westerberg, technical information service.

OLDS SUCCEEDED BY SMITH AS FPC CHAIRMAN

THE FEDERAL Power Commission announced that, at its meeting on December 17, Leland Olds asked to be relieved of the Chairmanship, a responsibility which he has had almost continuously for the past 7 years.

The Commission elected as Chairman, Nelson Lee Smith of Hopkinton, N.H., and as Vice Chairman, Richard Sachse of Fall Brook, Calif., effective January 1, 1947.

KONKLE ELECTED VP OF MAPI

THE EXECUTIVE COMMITTEE of Machinery & Allied Products Institute has announced the election of Alexander Konkle, Chicago, as Executive Vice President of MAPI. Mr. Konkle is said to be unusually well qualified for his new duties. He first became identified with the Institute in its early days in 1934 and served as its Secretary through 1940.

At that time Mr. Konkle became Executive Vice President of Kelly Steel Works, a position he has held for the past six years.

WISCONSIN U. OFFERS SAFETY INSTRUCTION

THE EXTENSION division of the University of Wisconsin is offering a new course, "Industrial Safety Engineering," for the benefit especially of supervisors and others having to do with safety rules in industry. The course is similar to one given in the wartime program of Engineering, Science, and Management War Training.

The course contains 24 assignments and uses four texts. Its scope, the fee, text information, and procedure for enrolling are being made known to inquirers by the University Extension Division at Madison, Wisconsin.

UTILITIES STATISTICS NOW AVAILABLE

IN ANNOUNCING issuance of the yearly publication "Statistics of Electric Utilities in the United States," the Federal Power Commission revealed that the report, which contains detailed financial information for 1945 on every important privately-owned electric utility in the U. S., shows further progress in elimination of write-ups and other intangibles from utility plant accounts.

As a result of write-offs during the year the recorded amount of utility plant investment at the end of 1945 was $14,490,782,000, or less than at any time since the end of 1940.

Further increases were shown in reserves for depreciation and the aggregate of reserves of the industry at the end of 1945 was $3,064,919,000 or 21.2 per cent of utility plant. Net plant, or total recorded investment less depreciation reserves, amounted to $11,425,863,000 at the end of the year.

The 342 utilities included in the compila-

(*Continued on Page 132*)

COMING EVENTS

ASTM—1947 Spring Meeting and Committee Week of the American Society for Testing Materials; to be held in Philadelphia, February 24 through 28, with headquarters at the Benjamin Franklin hotel.

Metals—Western Metal Congress and Exposition; to be held March 22 through 27, in San Francisco, with headquarters at the Oakland Civic Auditorium.

Power Conference—1947 annual meeting, Midwest Power Conference; to be held March 31, April 1 and 2 in Chicago, with headquarters at the Palmer House.

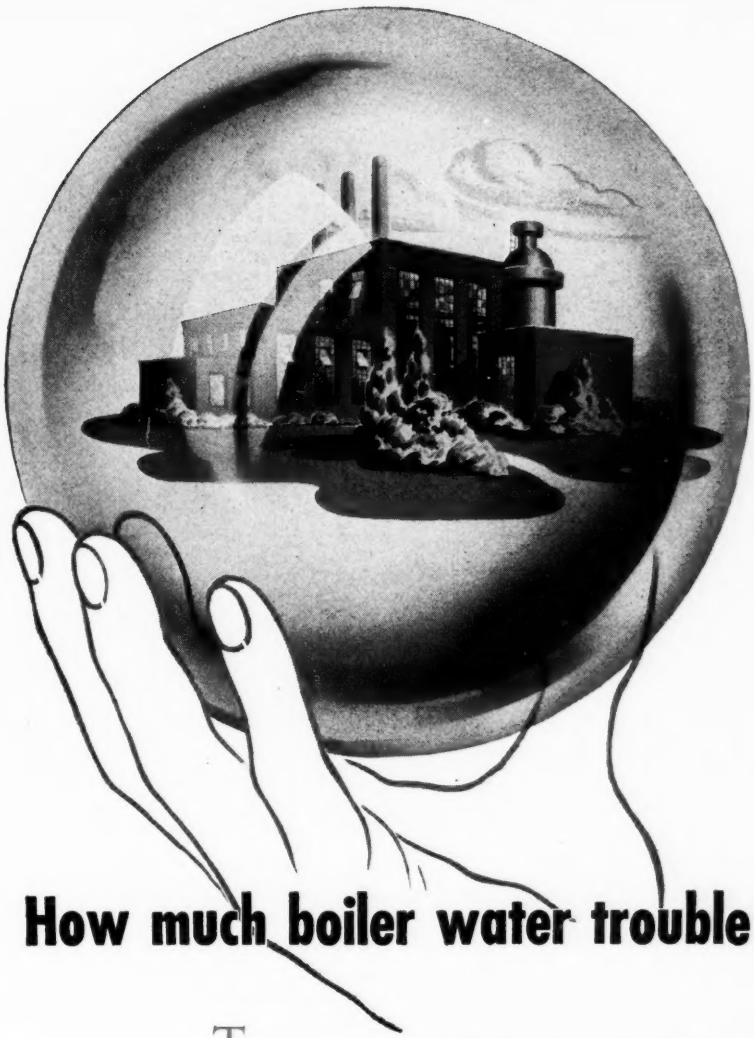
Stoker Manufacturers—Annual meeting of the Stoker Manufacturers' Association to be held June 16, 17 and 18; headquarters to be at Lookout Mountain Hotel, Lookout Mountain, Tenn.

ASTM—1947 Annual Meeting; to be held in Atlantic City, June 16 through 20, with headquarters at Chalfonte-Haddon Hall.

Instrument Society—Instrument Society of America annual meeting; to be held the week of September 8, 1947, with headquarters at the Stevens Hotel, Chicago.

Instrumentation Conference—Instrumentation Conference and Exhibit for 1947; to be held the week of September 8, with headquarters at the Stevens Hotel, Chicago.

XUM



How much boiler water trouble is necessary?

THE ANSWER ISN'T FOUND IN A CRYSTAL BALL . . . it's simpler than that . . . *it's as much (or as little) as your present boiler water treatment makes it.*

Think a moment about your present boiler water treatment. Does it eliminate carryover . . . minimize scale and corrosion . . . reduce blowdown and save fuel? How much boiler water trouble are you having, and how much of it is necessary?

There's no one solution to all boiler water problems. It takes more than just adding a few chemicals to the system. Good results require a completely *individualized* water conditioning service that includes initial investigation, plant control, a daily testing program, periodic check-ups, analyses of water samples and regular engineering reports on plant operation. Such a service is rendered by the BETZ organization . . . Write today for details on what BETZ engineers might do for you to improve your present boiler water treatment. W. H. & L. D. BETZ, Gillingham and Worth Sts., Philadelphia 24, Pa. In Canada: BETZ Laboratories Limited, Montreal 1.

BETZ

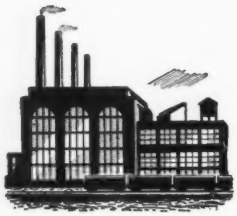
BOILER WATER CONDITIONING • COOLING WATER CONDITIONING • INDUSTRIAL WASTE TREATMENT

A Wartime Development of Interest to Power Plant Men

The **BADGER-KLEINSCHMIDT**

VAPOR COMPRESSION

WATER STILL



POSSIBLE INDUSTRIAL APPLICATIONS INCLUDE USE TO PURIFY HIGH PRESSURE BOILER FEED WATER

American commanders of troops assaulting the Pacific Islands never had to worry about water for their men.

Always at hand was an unlimited reservoir . . . *the sea.*

The link between the salty Pacific and pure drinking water was a distillation unit so efficient that a gallon of fresh water was obtained from the same heat input needed to bring a quart of water to the boil on a kitchen stove.

The unit was . . . ***the Badger-Kleinschmidt Vapor Compression Water Still,*** developed by Dr. R. V. Kleinschmidt of Arthur D. Little, Inc. and manufactured by E. B. Badger & Sons Co., Boston, Mass.

A major problem in designing the unit was the selection of materials. Combat use permitted a minimum of maintenance.

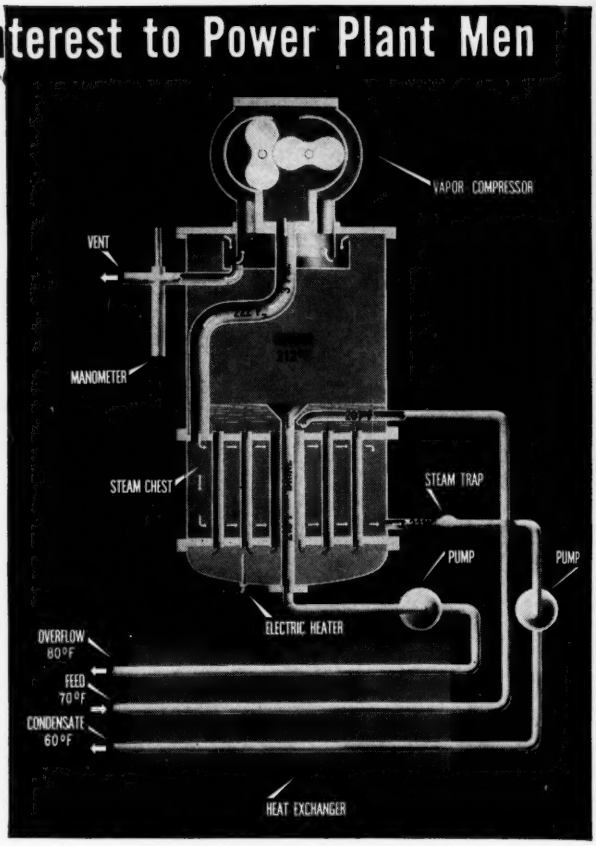
To counter the abrasive and corrosive conditions, nickel alloys were used throughout. For example, all sheet metal parts were made of a copper-nickel alloy. All nuts, bolts, studs, tie-rods, valves, piping and other fittings were Monel.*

With nickel alloys on the job it was no wonder that reports came back from the Pacific telling of Badger-Kleinschmidt stills operating smoothly even after their steel framework and housing had almost been completely eaten away.

That's why E. B. Badger & Sons Co. plans to continue using Monel in industrial vapor compression stills.

You build-in EXTRA performance when you use nickel alloys for equipment to handle steam or water.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

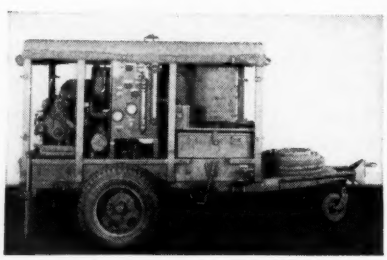


OPERATING PRINCIPLE

THE VAPOR COMPRESSION STILL'S conservation of heat is a close approach to perpetual motion. Feed water intake is through a heat exchanger. Sandwiched between concentric pipes carrying hot condensate and brine overflow, the feed water is raised to 207° F. Passing to the steam chest, it circulates through tubes surrounded by compressed steam at 222° F. This boils the water. The generated steam then goes to the compressor where it in turn is boosted to 222° F. Passing into the steam chest, it gives up most of its latent heat and boils new feed water. Then it passes through the heat exchanger and emerges as potable distillate.

In diesel-powered units, the exhaust supplies all the heat. In electric units, a separate electric heater is used. Thermal efficiency is 15 times that of ordinary single-phase stills.

TWO PUMPS are used on every B-K still. Many units are equipped with Warren SED vertical pumps. The SED, manufactured by WARREN STEAM PUMP Co., Warren, Mass., has a 1¼" Monel shaft and a "K" Monel shaft sleeve.



A PORTABLE B-K STILL used by the Army, Marines and Seabees. Fixed installations were aboard submarines and other Navy craft. E. B. BADGER & SONS Co. is ready to make stills up to capacities of 100,000 gallons per day. With these large-scale models available to economically distill high-pressure boiler feed water, boiler corrosion may well be licked.

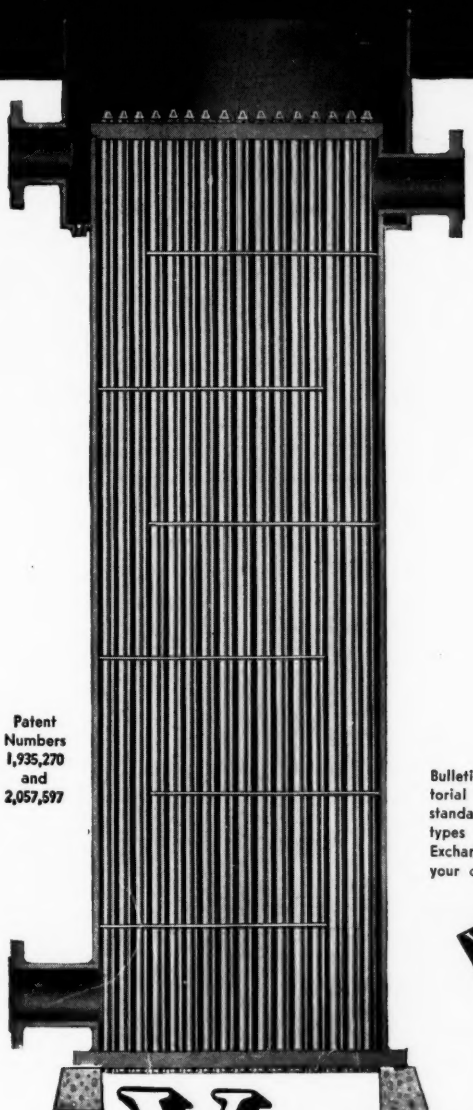
NICKEL (INCO TRADE MARK) **ALLOYS** MONEL* • "K"* MONEL • "KR"* MONEL • "R"* MONEL • "S"* MONEL • INCONEL* • NICKEL • "L"* NICKEL • "Z"* NICKEL

*Reg. U.S. Pat. Off.

XUM

FILM TYPE EXCHANGERS

DETAIL SHOWING DISTRIBUTING FERRULE IN TUBE (Patent Pending)



Patent Numbers 1,935,270 and 2,057,597

Vogt engineers have taken a familiar refrigeration plant "old timer" and developed it into this modern, efficient heat exchanger.

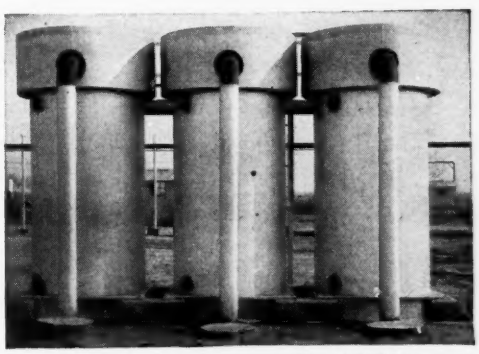
The film type exchanger operates in a vertical position. Water introduced in the top chamber is distributed in a thin film against the inner tube walls by means of special ferrules. The shell side of the exchanger has baffles arranged to provide optimum velocities, pressure drops, and heat transfer rates. Shutdowns are eliminated because tubes can be cleaned while the unit is in operation; thus permitting the use of dirty, mud and silt depositing water.

Vogt Film Type Exchangers now serve as Jacket Water Coolers, Sulphuric Acid Coolers, and Sulphur Dioxide Condensers, and can be designed to condense any vapor. They are also applicable for handling liquids other than water in film flow.

HENRY VOGT MACHINE CO., INC.
LOUISVILLE 10, KENTUCKY

Branch Offices: New York, Philadelphia, Cleveland, Chicago, St. Louis, Dallas

Bulletin HE-5 is a pictorial presentation of standard and special types of Vogt Heat Exchangers. Write for your copy.



Jacket Water Coolers serving engines of 7,300 H.P. Muddy well water used as cooling medium.

Vogt

HEAT TRANSFER EQUIPMENT

K-68 . . . AN OUTSTANDING SHEET PACKING

K-68 gives outstanding results where unusual resilience must be combined with resistance to oil and to extremely high temperatures. K-68 sheets are made of specially selected asbestos fibres and bonded under great pressure with Neoprene.

K-68 sheets are recommended for aviation and Diesel engines and applications in oil refineries and chemical plants where they must stand up against solvent and aromatic conditions at extreme heat. Because K-68 contains no sulphur it is also valuable in refrigeration service.

For applications where the special characteristics of K-68 are not required, R/M offers a number of other sheet packings, among which are R/M Style No. 650, the famous "Pyroid" brand; R/M Style No. 670, which is approved by the National Board of Fire Underwriters.

For all your sheet or other packing needs see your authorized R/M distributor.

ASBESTOS TEXTILE & PACKING DIVISION

RAYBESTOS-MANHATTAN, INC.
MANHEIM, PA.

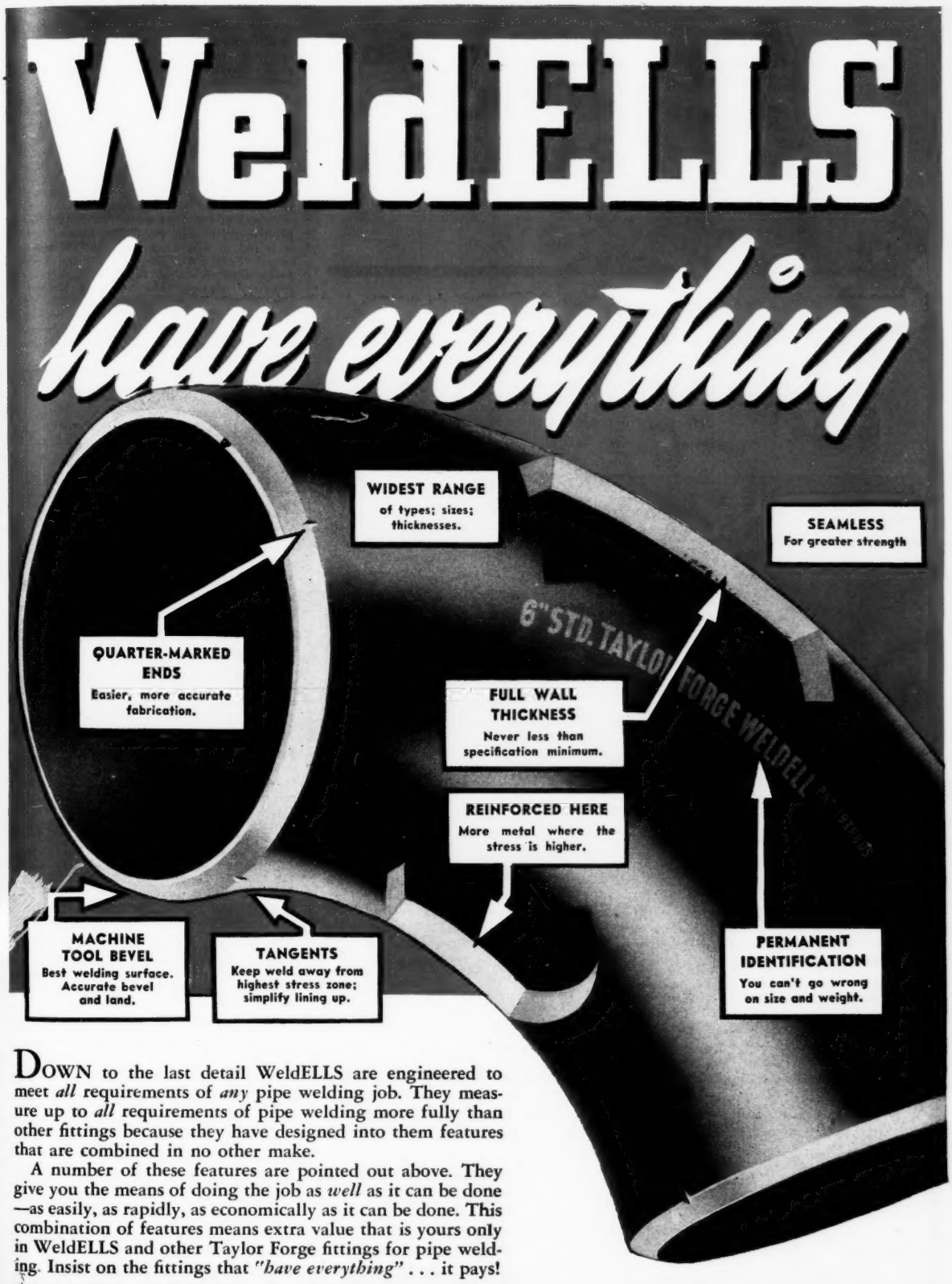
Style No. 686

R/M

RAYBESTOS R M MANHATTAN

It's "Packed with Satisfaction" when you use R/M

WeldELLS *have everything*


WIDEST RANGE
of types; sizes; thicknesses.
SEAMLESS
For greater strength
QUARTER-MARKED ENDS
Easier, more accurate fabrication.
FULL WALL THICKNESS
Never less than specification minimum.
REINFORCED HERE
More metal where the stress is higher.
MACHINE TOOL BEVEL
Best welding surface. Accurate bevel and land.
TANGENTS
Keep weld away from highest stress zone; simplify lining up.
PERMANENT IDENTIFICATION
You can't go wrong on size and weight.

DOWN to the last detail WeldELLS are engineered to meet *all* requirements of *any* pipe welding job. They measure up to *all* requirements of pipe welding more fully than other fittings because they have designed into them features that are combined in no other make.

A number of these features are pointed out above. They give you the means of doing the job as *well* as it can be done —as easily, as rapidly, as economically as it can be done. This combination of features means extra value that is yours only in WeldELLS and other Taylor Forge fittings for pipe welding. Insist on the fittings that *"have everything"* . . . it pays!

TAYLOR FORGE & PIPE WORKS

General Offices & Works: P. O. Box 485, Chicago

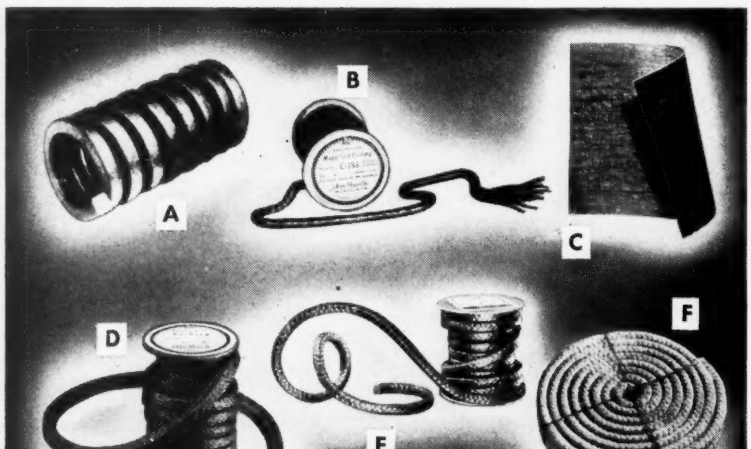
New York Office: 30 Church Street • Philadelphia Office: Broad Street Station Bldg. • Los Angeles Office: Subway Terminal Bldg.

The sign of a GOOD PACKING

JOHNS-MANVILLE JM PRODUCTS

The J-M Trade Mark is and long has been a familiar sign throughout industry of an effective seal . . . *the sign of a packing that means lower maintenance costs and less shutdown time.*

Here are 6 typical Johns-Manville Packings designed to meet a wide range of service conditions.



A. J-M Kearsarge. A long-wearing rod and plunger packing with a unique folded construction that forms a reservoir for the preserving lubricant.

B. J-M Mogul Packing. For general utility service . . . braided and twisted styles lubricated inside and out for longer life.

C. J-M Service Sheet. A tough, pliable, resilient gasket material with a wide range of applications. Industry's No. 1 sheet packing.

D. J-M Interlocked. A rugged, durable, square-braided packing, without plaits or jackets to loosen . . . for reciprocating and rotating rods.

E. J-M Centripac. Designed especially for packing centrifugal pumps and other rotating and oscillating rods and shafts.

F. J-M Navalon. A newly developed packing for cold liquid service. Contains and retains more lubricant in service; long-wearing, abrasive-free.

See your J-M Packing Distributor or write Johns-Manville, Box 290, New York 16, N. Y.

Johns-Manville PACKINGS & GASKETS

(*Continued from Page 126*)

tion represent on the basis of both assets and revenues over 98 per cent of the entire privately-owned electric light and power industry in the country. The report includes composite financial statements for these companies for recent years, thus affording an overall picture of the financial development of the electric utility industry as a whole during the period in which policies contained in the Federal Power Act have affected the industry's accounting practices. Composite balance sheets and income statements taken from the report are attached.

Copies of the 1945 edition of "Statistics of Electric Utilities in the United States," which is bound in blue cloth, and may be referred to as "FPC S-47," are sold by the Federal Power Commission at $2.00 each. A 14-page summary entitled "The Financial Record of the Electric Utility Industry" for the years 1937 through 1945 is available free upon request to the Commission. The summary may be referred to as "FPC S-47-A."

METALLURGY SESSIONS ADDED TO POWER CONFERENCE

DISCUSSION sessions on Metallurgy of Power Plants, Industrial Electronics and Railroad Power Units will be added to the program of the ninth annual meeting of the Midwest Power Conference March 31, April 1 and 2 at the Palmer House Hotel, Chicago.

Added to the conference program because of the growing interest and activity in the fields, the sessions are among the new features of the Conference that also include a general session on civic responsibilities of the engineer to be sponsored by the Western Society of Engineers.

The Conference will again be sponsored by Illinois Institute of Technology in cooperation with nine midwestern colleges and universities and seven engineering societies. Stanton E. Winston, dean of the evening division at IIT, will serve his eighth term as director of the conference, and Edwin E. Whitehead, research professor at Illinois Tech, is the newly appointed secretary.

SCHWANHAUSSER RE-ELECTED HEAD OF DIESEL GROUP

E. J. SCHWANHAUSSER, Vice-President of Worthington Pump & Machinery Corp., was re-elected President of the Diesel Engine Manufacturers Assn. at the Association's Annual Meeting held December 11 in Chicago.

Also returned to their posts as Vice-Presidents of the Association were J. E. Peterson, Vice-President of General Machinery Corp., and Gordon Lefebvre, President of Cooper-Bessemer Corp. Robert H. Morse, Jr., Vice-President and General Sales Manager of Fairbanks, Morse & Co., was again chosen to serve as Treasurer.

Directors were elected as follows: William E. Corrigan, Vice-President of American Locomotive Co.; George W. Codrington, Vice-President of General Motors Corp. and General Manager, Cleveland Diesel Engine Division; A. W. McKinney, Vice-President and General Manager of Sales, National Supply Co.; Robert E. Friend, President, Nordberg Mfg. Co.; Norris H. Schwenk, President of Busch-Sulzer Bros.-Diesel Engine Co.; and G. F. Twist, Vice-President and General Manager, Atlas Imperial Diesel Engine Co.

WESTERN METAL CONGRESS EXPECTS HIGH ATTENDANCE

MORE THAN 40,000 metals scientists, engineers and executives are expected to attend the 5th Western Metal Congress and Exposition which will be held in two Oakland Civic Auditoriums in the San Francisco-Oakland-Golden Gate area for six days beginning March 22nd, 1947.

W. H. Eisenman, Managing Director of the Exposition and also national secretary of the American Society for Metals, stated that the estimate is based upon attendance figures of the last previous Western Metals Congress and Exposition held in Los Angeles in 1941.

"Current interest in the progress made in metal alloys, metals manufacturing and fab-

ricating equipment and other phases of the metals industries is at a high point," Mr. Eisenman said. "Never before have we seen such a manifestation of interest in the field. Attendance at the recently held National Metals Congress and Exposition at Atlantic City showed without question that general interest in achievements of the field is at an all time high."

It was pointed out that further evidence of interest is the fact that more manufacturers of metals industries products are showing in 1947 than ever before in a Western Metal Show. Too, the technical programs already completed show more than 75 technical papers, lecture courses and 'round table discussions, also a new high for this event.

Sixteen western divisions of technical societies are actively co-operating in program and other activities of the Western Metal Congress and Exposition. The list includes the American Society for Metals, sponsors of the event; The American Chemical Society; the American Foundrymen's Association; The American Industrial Radium and X-Ray Society; The American Institute of Mining and Metallurgical Engineers; The American Institute of Electrical Engineers; The American Society for Testing Materials; The American Society of Tool Engineers, Inc.; The American Welding Society; The Mining Association of California; The Northwest Electric Light and Power Association; The Pacific Coast Electric Association; The Purchasing Agents Association of California, Inc.; Society of Automotive Engineers; Western Oil and Gas Association and the American Petroleum Institute.

All technical sessions and other educational activities of the co-operating societies will be held in the Oakland Civic Auditoriums, the Auditorium Arena and the Auditorium Exhibit Hall, same buildings where the Exposition will take place.

The technical program will open its activities on Monday, March 24th, and will continue through Thursday, March 27th. Members of co-operating societies will attend sessions to be addressed by nationally renowned technical speakers. Daily meetings will begin at 9 a.m. and during the day until 5 p.m. and are expected to attract capacity audiences.

USES MERGES TWO SCIENTIFIC PLACEMENT SERVICES

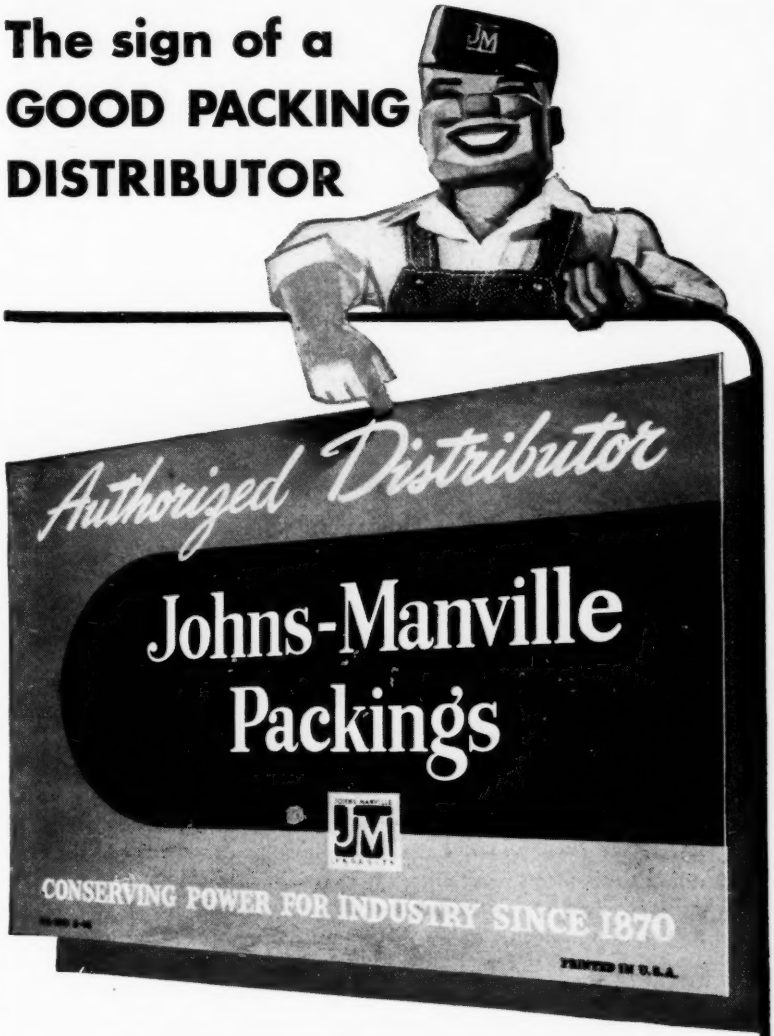
THE PLACEMENT services of the United States Employment Service for scientific and professional personnel have been augmented by merger of the placement service of the National Roster of Scientific and Professional Personnel with the USES National Clearing House.

The National Clearing House will operate through the 1800 local State Employment Service offices so that registrants with executive, professional and scientific qualifications and experience may be placed in contact with employers in need of their services anywhere in the country or overseas. The National Roster maintains an active file on the qualifications of the country's scientific and professional personnel. More than 50,000 highly skilled individuals from the Roster's files were placed in war industry and in specialized posts in the armed services during the war years.

SHELL FILM CLARIFIES TURBINE LUBRICATION

THE SHELL OIL CO's. educational training film, "Lubrication of Turbine Systems," which was produced for the United States Navy Department Bureau of Ships, is now available to all parties interested in the operation of turbines, the company announced recently. The film, a result of extensive research, shows the great advances made during the war in turbine lubrication and uses the technique of both live action and animated drawings.

At beginning of the war, the company, which had already developed highly stable rust-inhibited turbine oils for stationary units, was requested by U. S. Navy to develop similar oil with higher specifications for combat vessels. For several years, according to the announcement, Shell was supplying the



WHEN you need a packing—you'll find, as thousands of others have, that the sign, Authorized Distributor—Johns-Manville Packings—means the right packing for your job . . . and a man who is ready and able to help solve your particular packing problem.

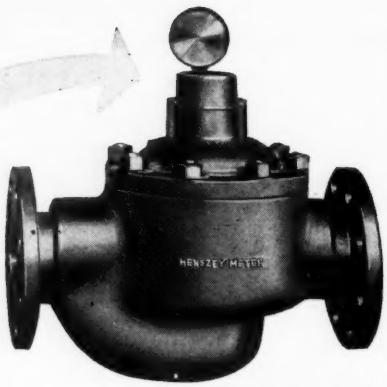
Your J-M Distributor is one of 400 Industrial Distributors who are located in important cities throughout the country and who stock Johns-Manville Packing in many forms and styles. Besides being a convenient supply depot for packing, he is also headquarters for many other industrial supplies. Wherever there's a need for an essential part or tool or material, you can count on him for prompt, efficient service at all times.

Packings For Every Service are available through your J-M Distributor. See him about your Packing needs.

JM PRODUCTS

Your **Johns-Manville**
PACKING DISTRIBUTOR

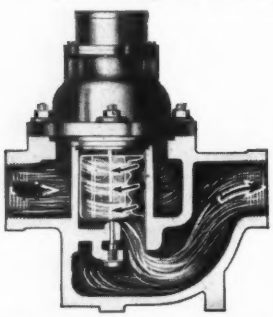
Accurately MEASURE *in* GALLONS, POUNDS, *or* CUBIC FEET!



HENSZEY *Feed Water* METERS

can be calibrated to suit your specific needs.

These simple rugged meters do an outstanding job of measuring boiler feed water, boiler blowdown, condensate, free-running chemicals, and other "hard-to-measure" liquids. The straight reading horizontal register accurately records any liquid at high or low flow — high or low pressure — on centrifugal or reciprocating pumps. They can be installed right in the line . . . no additional supports are needed.



If you have a liquid measuring problem that demands accuracy in readings of gallons, pounds, or cubic feet, consider the reliable Henszey Feed Water Meter. Ask for details.

SIMPLICITY WITH ACCURACY

Liquid enters the measuring chamber tangentially, spinning in the chamber as it passes through, forming a vortex. Each unit of liquid passing through this chamber makes the same number of revolutions. A vane placed in the liquid imparts this rotation to the calibrated register. A minimum of working parts without close clearances.

HENSZEY COMPANY

DEPT. C2, WATERTOWN, WIS.

HENSZEY

FEED WATER METERS

Continuous Blowdown • Distillation Systems • Heat Exchangers
Boiler Feed Regulators • Flow Indicators • Proportioning Valves
also MILK EVAPORATORS and PRE-HEATERS

greater proportion of the Navy's total requirements of this oil during the last fiscal year.

"Lubrication of Turbine Systems" requires 30 minutes for screening, and is a 16 mm., black and white, sound film. It explains the functions and characteristics of turbine oil in the power plant of a modern destroyer, stressing that it must lubricate, cool and act as a hydraulic medium. Standard laboratory tests are pictured to clarify demulsibility, foam resistance, rust prevention, oxidation stability and other characteristics. Good maintenance and cleanliness are emphasized for long life and trouble free operation of turbine. Commercialism is avoided throughout.

The film begins with views of turbines in builder's shop. Arrangement of a typical pressure circulating turbine lubricating system is shown. Sump, pumps, strainers and coolers are described and illustrated. Purifying system is explained in connection with settling and centrifuging of the oil.

Although industrial power plant turbines usually require lighter viscosity oil, most of the components described in the motion picture are found in land power plants, Shell stated.

Film is now available for general distribution from Shell Oil Co., Inc., 50 West 50th Street, New York 20, New York.

COMPTON RECEIVES WASHINGTON AWARD

THE WASHINGTON AWARD in recognition of devoted and pre-eminent service of human progress, was conferred upon Dr. Karl T. Compton, President, Massachusetts Institute of Technology, by the Western Society of Engineers on Feb. 26th, in the Grand Ballroom of the Continental Hotel, Chicago, for his scientific and engineering activities, which have contributed considerably in the happiness, comfort and well-being of humanity.

Dr. Compton has always stressed the opportunities and obligation for technical institutions and men to render public service in which he personally had made a generous contribution.

As President of Massachusetts Institute of Technology, his contributions in the field of administration include notable developments in the program of scientific and engineering education and fundamental research.

BCR APPROVES BUDGET OF $447,200 FOR RESEARCH

FAITH IN the future of the bituminous coal industry was reaffirmed recently by the Board of Directors of Bituminous Coal Research, Inc., national research agency of the industry, when it approved a budget of $447,200 for its general program of cooperative research and development projects to be carried on during 1947. This is in addition to large expenditures planned in 1947 for coal-burning gas-turbine locomotive research and development by the BCR Locomotive Development Committee.

Howard N. Eavenson, Pittsburgh, president of BCR, announced that this budget was higher by $72,200 than the allotment made for research in 1946. The funds were made possible by voluntary contributions from coal companies and associations, coal-carrying railroads and coal-burning equipment manufacturers.

As in 1946, next year's BCR program will be an expansion as well as a continuation of development work begun earlier. In 1947, Dr. Harold J. Rose, vice president and director of research stated, the BCR projects will include six on railroad locomotive utilization of coal, 15 on residential uses, eight on industrial steam and non-steam uses, and two on mining and preparation.

New BCR projects in the locomotive field include front-end cinder collection and disposal and investigations by a special steam locomotive performance subcommittee. Work will continue on air supply for locomotives, overfire air jets to eliminate smoke, effect

For trouble-free flow control ....install POWELL Valves

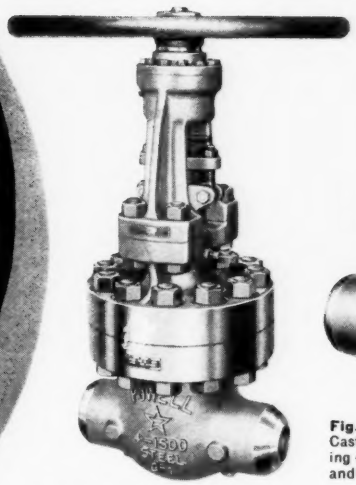


Fig. 1303 W. E. — Class 1500-pound Cast Steel Gate Valve, with welding ends, outside screw rising stem and bolted flanged yoke.

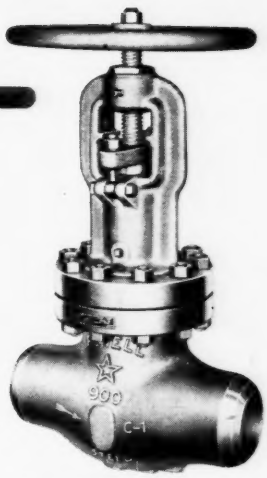


Fig. 9031 W. E.—Class 900-pound Cast Steel Globe Valve, with welding ends, outside screw rising stem and bolted flanged yoke.

There are at least two notable reasons why Powell Valves minimize flow control troubles. One is that every valve in the Powell Line has been scientifically designed to operate under certain specific flow control conditions—pressure, temperature and/or media. The other is that there's a Powell Valve for *every* operating condition, or set of conditions, known today.

That's why so many plants, representing every phase of modern industry, are now standardizing on Powell Valves.

Class 1500-pound 8" Cast Steel Gate Valve with welding ends, welded bonnet and special by-pass. Top mounted electric motor operator assures quick, positive opening and closing by remote control.

Class 900-pound 14" Cast Steel non-return Globe Valve, with pressure seal bonnet and welding ends. Compound spur gearing for easy operation.

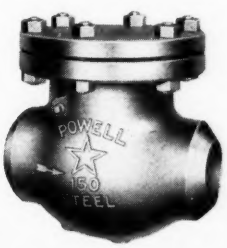


Fig. 1561 W. E.—Class 150-pound Cast Steel Swing Check Valve with welding ends and bolted flanged cap.

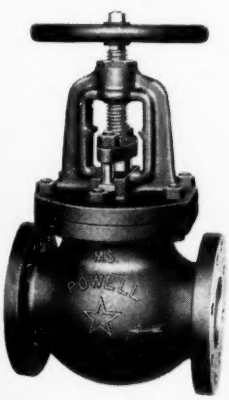


Fig. 241—125-pound Iron Body Bronze Mounted Globe Valve. Has flanged ends, outside screw rising stem, bolted flanged yoke, and regrindable, renewable bronze seat and disc. Also available in All Iron.

The Wm. Powell Co., Cincinnati 22, Ohio

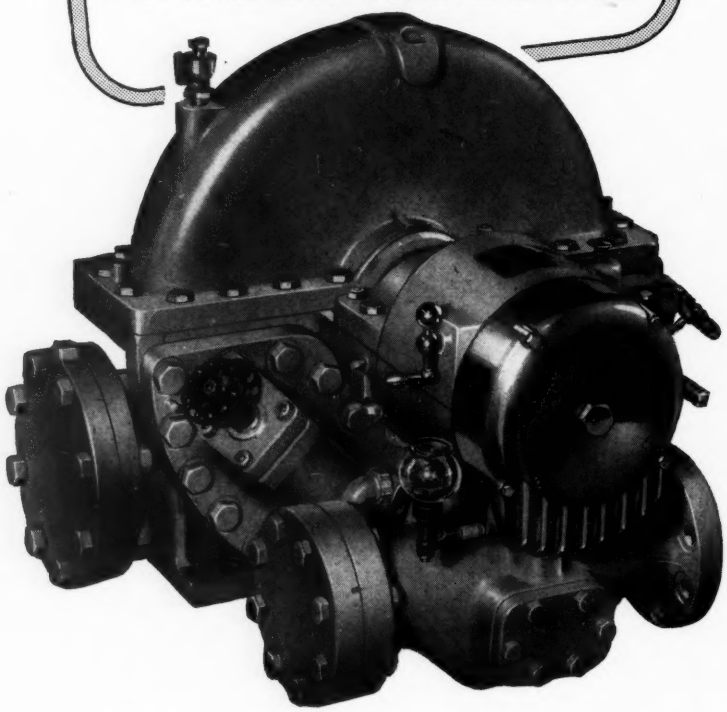
DISTRIBUTORS AND STOCKS IN ALL PRINCIPAL CITIES

POWELL VALVES

MURRAY

TYPE S

SINGLE STAGE TURBINES
FOR MECHANICAL DRIVE



Murray Type S single stage turbines for mechanical drive have horizontally split casing with steam and exhaust connections in lower half. Two-row impulse type stainless steel blading. Completely enclosed constant speed governor and emergency overspeed governor. Carbon ring glands. The unit is compact with the ruggedness expected on this type drive. Suitable for driving centrifugal pumps, fans, blowers, and small generators.

Write today for Murray Bulletin 121—it illustrates and describes in detail Murray Type S Turbines.

Murray also produces:

Turbine Generators up to 3,000 KW rating. High speed reduction gears.
Vertical Steam Turbines, both direct connected and geared. Steam Boilers.

MURRAY IRON WORKS COMPANY
BURLINGTON, IOWA
BUILDERS OF STEAM POWER EQUIPMENT FOR THREE QUARTERS OF A CENTURY

of fuel on locomotive performance, and handling locomotive coal to minimize breakage. The principal research will be done in the fuels division of Battelle Memorial Institute.

The industrial steam and non-steam uses to be studied by BCR—also to be handled at Battelle—include overfire air for fuel beds, stoker and boiler-furnace designs, and gasification of pulverized coal. Another project relates to the flow of mixtures of pulverized coal and air, including metering. Studies of the drying of coal fines will be continued.

BCR will continue to be a major contributor to fundamental research at the Coal Research Laboratory of Carnegie Institute of Technology, Pittsburgh, and has special interest in the basic work on combustion and gasification reactions, heat transfer into coal during carbonization and combustion, coke quality, and production of chemicals by hydrogenating coal.

The approved budget also will enable the research agency to continue administration of the development program, carry on its technical information service, publish a quarterly news bulletin as well as technical reports and information bulletins, and provide technical service leading to commercial trial of research developments.

NEW AUTHORIZATIONS FOR NATURAL GAS PIPELINES

NEW CONSTRUCTION and operation authorizations expected to make available to 71 large cities and many smaller communities an additional volume of more than a billion cubic feet of natural gas daily have been approved by the Federal Power Commission within recent months.

Many communities urgently needing additional supplies of natural gas to meet rapidly expanding demand for home heating will benefit as result of issuance by the FPC between July 1, 1945 and September 30, 1946 of 90 certificates of public convenience and necessity for construction and operation of natural gas transportation facilities, Mr. Olds said. The new construction was planned to take place in 18 states and was intended to add at least 1,106,000,000 cubic feet of natural gas daily to the aggregate supply of several score of communities in many parts of the country.

F. R. LACK NEW PRESIDENT OF ASA

FREDERICK R. LACK, vice president of Western Electric Co. will be president of the American Standards Association for the ensuing year, it was announced recently at the concluding session of the two-day annual meeting at the Waldorf-Astoria.

Mr. Lack succeeds Henry B. Bryans, executive vice president of the Philadelphia Electric Co. Mr. Lack formerly was vice president of the ASA.

George H. Taber, Jr. will be vice president of the Association for the coming year. He is executive vice president of the Sinclair Refining Co. and already was a member of the Board of Directors of the ASA.

U.S. FIRST TO RATIFY STANDARDS CONVENTION

THE UNITED STATES has become the first country to ratify the convention setting up the 25 nation International Organization for Standardization (ISO), P. G. Agnew, vice president and secretary of the American Standards Association, announced recently. Action was taken at a recent meeting of the directors of ASA.

Dr. Agnew revealed he had received cabled notice from Charles le Maistre, secretary of the United Nations Standards Coordinating Committee, which continues in existence until the ISO office is set up at Geneva, Switzerland, that the United States was first under the wire with its official acceptance of the new constitution and by-laws.

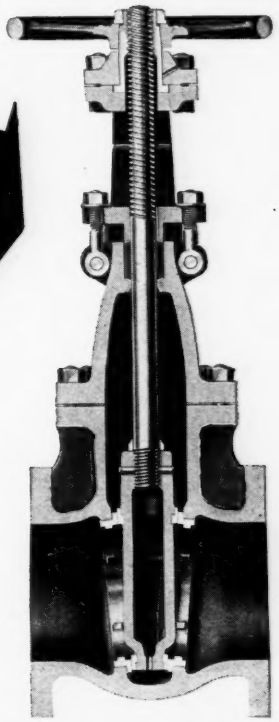
The pressure for standardization work which will aid the flow of goods in international trade has been so great, Dr. Agnew said, that scores of projects are being proposed for ISO action.

The wide range of interest displayed was indicated, he said, in a list of 64 projects

Every feature you want in an

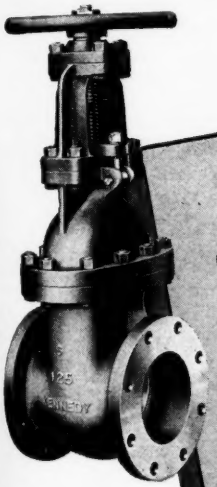
IRON BODY WEDGE GATE VALVE

is in this KENNEDY DESIGN



Whether you examine this Kennedy Standard Iron Body Wedge Gate Valve for basic features that assure ample strength, long service and trouble-free operation, or for refinements that provide extra conveniences and ease of assembly, operation and maintenance, you will find a design that gives you extra values . . . at no extra cost.

Engineers who have tried these valves have become so enthusiastic about their many superiorities that plants all over the country have standardized on them for iron-body wedge gate valve services. These superiorities are fully described in the 240-page Kennedy Catalog, which also shows the entire Kennedy line of bronze and iron body gate, globe, angle and check valves, malleable iron and bronze screwed pipe fittings, and cast iron flanged fittings and flanges. Be sure to write for your copy today . . . you will find it a valuable help in the selection of valves and pipe fittings for your requirements.



Buy From Our Distributor

YOU WANT THESE VALVE FEATURES

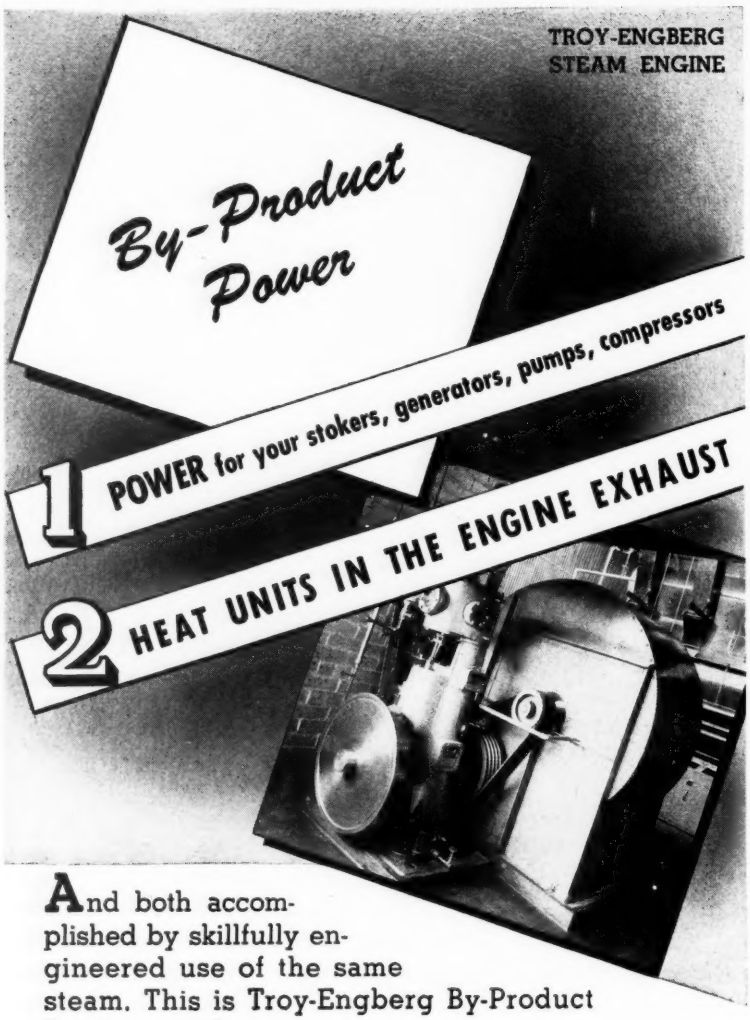
. . . you'll find them in this KENNEDY design

1. **Generous Strength . . .** Body and bonnet are of high-grade dense metal with ample thickness and rounded fillets. Stem has large diameter and extra large number of contact threads.
2. **Easy Operation . . .** Stem and stem contact surfaces are accurately threaded. Deep stuffing boxes permit tightness without undue pressure on packing. Large handwheel gives firm, comfortable grip.
3. **Lasting Tightness . . .** Discs and seats seat accurately, and their sturdy design resists distortion and has special provisions for take-up of wear.
4. **Long Life . . .** Many Kennedy valves have been in daily use a quarter century and more.
5. **Convenient Repacking . . .** Glands and packing are easily accessible.
6. **Economical Maintenance . . .** Long wear built into all parts, and adjustments or other attention are seldom required.

THE KENNEDY VALVE MFG. CO.
Elmira, New York

KV-137

KENNEDY *valves - pipe fittings - fire hydrants*


TROY-ENGBERG
STEAM ENGINE
By-Product Power
1 POWER for your stokers, generators, pumps, compressors
2 HEAT UNITS IN THE ENGINE EXHAUST

And both accomplished by skillfully engineered use of the same steam. This is Troy-Engberg By-Product Power at work.

Use the modern Troy-Engberg Steam Engine to drive stokers, blowers, fans, compressors, mixers, generators and pumps—THEN use the exhaust from the engine for your processing or heating, or both.

Cut Power Costs by putting your steam fully to WORK. Write us for detailed information on applying Troy-Engberg By-Product Power to your plant.

Send for Bulletin 306

TROY ENGINE & MACHINE COMPANY
Established 1870
896 Railroad Avenue Troy, Pennsylvania

TROY-ENGBERG
STEAM ENGINES • GENERATING SETS • GENERATORS

now accepted for ISO action. Seventeen nations have accepted the technical leadership in forwarding one or more of these projects. In each case technical leadership in a given project will be taken by a country in which the industry concerned is well developed.

DR. BUSH TO RECEIVE HOOVER MEDAL

DR. VANNEVAR BUSH, President of Carnegie Institution of Washington, and wartime Director of the Office of Scientific Research and Development, has been named 1946 winner of the Hoover Medal, joinly awarded by four national engineering societies. The medal is of gold and bears the inscription: "Awarded by Engineers to a Fellow-Engineer for Distinguished Public Service."

The citation for Dr. Bush reads as follows: "Engineer, educator, and administrator, who, in critical time of need, was in a most special sense an organizer, guiding spirit, and driving force of the nation's achievements in physical and medical science; to whom, for outstanding public service, is awarded the Hoover Medal for 1946."

The Hoover Medal is deemed one of the outstanding honors of the engineering profession. As stated in the organization and by-laws of the Hoover Medal Board of Award, it is given "to honor engineers whose pre-eminent services have advanced the well-being of mankind and whose talents have been devoted to the development of a richer and more enduring civilization."

BUREAU CONTEMPLATES $36,500,000 IN CONTRACTS

THE BUREAU of Reclamation plans to grant $36,500,000 in additional construction contracts in 1947 to speed the building of irrigation works for the million-acre Columbia Basin Project if sufficient funds are granted by Congress it was announced recently.

It was said the Bureau now has $33,887,000 in construction contracts in force on the project in Eastern Washington, and the additional jobs planned for next year, subject to Congressional approval, would bring the total to $70,387,000.

NOVEL RADIANT HEATING FOR COLO. PUBLIC SERVICE CO.

WHAT IS BELIEVED to be the first new building in which radiant heating is incorporated not only in room flooring but also in stair steps is the South Terminal Control Building now under construction in Denver for the Public Service Co. of Colorado.

The basement of the one-story building also will be radiant heated, it was reported.

The utility company expects to begin use of the building in the spring or summer of 1947.

General contractors are Dutton, Kendall & Hunt., Inc., Denver. The Midwest Plumbing & Heating Co., Denver, is handling the radiant heating installation, which involves use of 1800 ft of 1 in. wrought iron pipe and 180 ft. of 1½ in. size for the main. The pipe lengths are being bent and gas-welded together at the job site to form grids which in turn are suported on reinforcing steel chairs embedded in the monolithic concrete slab flooring, under steps leading to the basement, and in the basement concrete flooring.

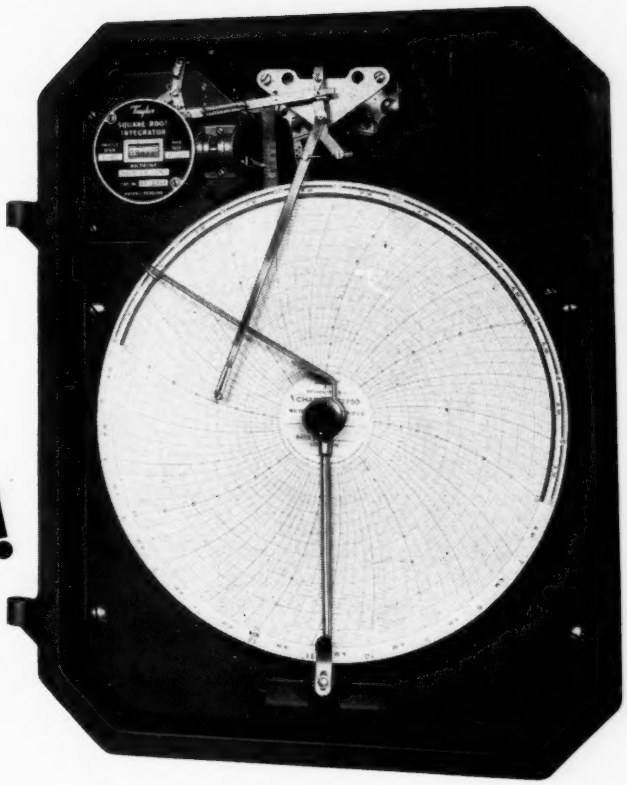
Designer of the radiant heating system was George Adams, of Midwest Plumbing & Heating Co. The system was designed, he reports, to compensate for a calculated total heat loss of the building of 144,000 Btu—including downward loss—and to meet a minimum outdoor temperature of —10 F.

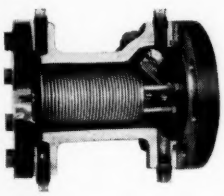
IRON AND STEEL ASSN. NAMES 1947 OFFICERS

L. R. MILBURN, electrical engineer, Great Lakes Steel Corp., Ecorse, Mich., has been elected president of the Association of Iron and Steel Engineers for the year 1947.

Born in Patoka, Indiana, where he attended grade and high schools, Mr. Milburn graduated from the University of Michigan and served in the United States Army during World War I. He remained active in army

LOOK! A new Integrator!





JUST announced for use with the Taylor Aneroid (left) and Mercury Flowmeters, the Taylor Square Root Integrator! Accurately totalizes the flow of liquids, and of gases and steam under constant pressure.

1. Easy to read—Large (2-inch) window in case door.

2. Positive Drive—Synchronous motor drives counter thru positively controlled clutch without the use of ratchets.

3. Continuous visual check—On accuracy of calibration at any point of range.

4. Long life—Both Oilite and ball bearings.

5. Accuracy of indication—Large cam surface assures uniform accuracy.

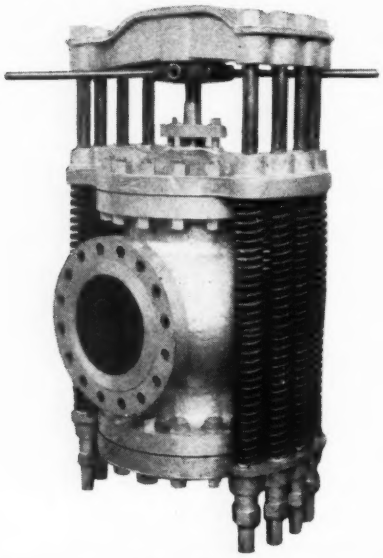
6. Simplicity—Few moving parts; permanently lubricated cam rollers, self-lubricated bushings; positive, oil-proof counter clutch.

Together with a Taylor Aneroid or Mercury Flowmeter, this new Integrator will give you reliable measurement of the flow of liquids, gases and steam.

The Taylor Aneroid (mercury-less) Manometer is a war veteran, thoroughly field-tested in wartime chemical and petroleum plants. New manufacturing techniques now make it better than ever. No mercury, no pivots, no stuffing box! Nothing to replace or wear out. You can depend on its accuracy. Ask your Taylor Field Engineer or write for Catalog *98175. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada. *Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.*

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

A VALVE THAT WILL INTEREST EVERY POWER ENGINEER



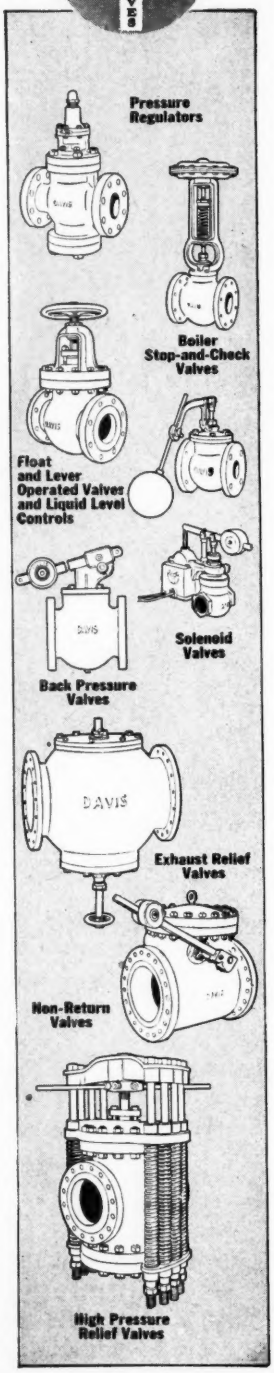
The DAVIS No. 265 HIGH PRESSURE RELIEF VALVE

USES.— (1) For turbine relief on bleeder system. (2) For protection of any boiler room or process equipment by relief to atmosphere. (3) For relief of high pressure lines to low pressure lines at predetermined pressure. (4) For use in plants carrying multiple boiler pressures to protect lower pressure systems.

ADVANTAGES.— Multiple springs result in less spring accumulation . . . less build-up for maximum relief . . . less blowdown to close. Compact design with springs at sides reduces headroom requirements. Center adjusting screw available for quick, easy change of pressure setting.

BUILT TO MEET YOUR REQUIREMENTS.— Offered in sizes from 4" to 30" in semi-steel or steel with bronze or stainless steel trim. Test lever and hold-open device available when desired. Detailed information on request.

DAVIS VALVES



DAVIS REGULATOR CO.

Representatives in All Principal Cities

2508 S. WASHTENAW AVE., CHICAGO 8, ILL.

reserve work, attaining the rank of major. After experience with General Electric Co., Mr. Milburn moved to the Louisville Gas and Electric Co., and in 1929 went to Great Lakes Steel Corp. He was appointed to his present position in 1935.

As president of the AISE for 1947, Mr. Milburn will help the Association celebrate its 40th year of service to the nation's iron and steel industry. Founded in 1907 as a means of fostering the exchange of ideas and furthering the electrification of the iron and steel industry, the Association has enjoyed a healthy growth and has greatly amplified the scope of its activities, now embracing all the various divisions of steel plant engineering and operation. Engineering divisions now functioning within the Association include the electrical, mechanical, fuel, and power, lubrication, welding, operating practice and rolling mill fields.

A. J. Fisher, Fuel engineer, Bethlehem Steel Co., Sparrows Point, Maryland was elected first vice president; C. H. Williams, chief engineer, Pittsburgh district, Carnegie-Illinois Steel Corp. was elected second vice president; A. S. Glossbrenner, assistant vice president in charge of operations, Youngstown Sheet and Tube Co., was elected treasurer; and, John F. Black, assistant works manager, Atlas Steels, Ltd., Welland, Ontario, Canada, was elected secretary.

NEW COAL HANDLING SYSTEM AT TOLEDO EDISON CO.

AN $800,000 coal-handling system designed to accommodate a plant burning rate of 50,000 tons of coal a month has been installed in the Acme plant of the Toledo Edison Co., Toledo, O.

Replacing 30-year-old equipment which was designed for less than half of Acme's present capacity, the new coal-handling system can be operated by a single eight-hour shift working 40 hours a week to provide all of the plant's fuel needs.

The system consists of a car-dumper, Bradford breaker and four silos with a total capacity of 2,000 tons all connected by a belt conveyor system. H. H. Kerr, vice president in charge of the Edison Co., and Glenn Sampson, engineer in charge of construction, supervised its installation.

1947 NATIONAL ELECTRICAL CODE AVAILABLE

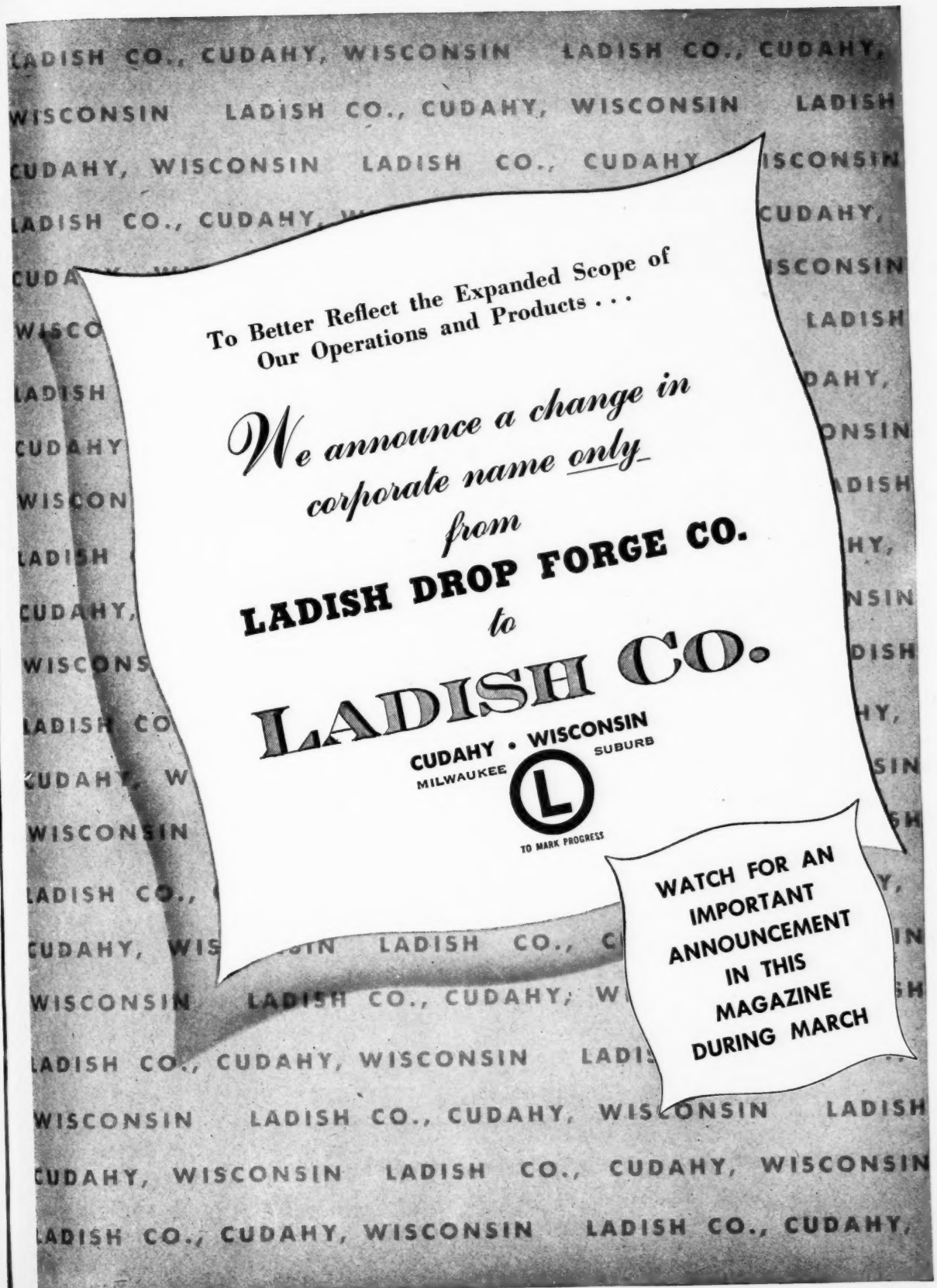
THE NATIONAL Fire Protection Assn. has just published the 1947 edition of the National Electrical Code, which is the "Bible of the Electrical Industry" and the safety blueprint which protects even the simplest electrical installation.

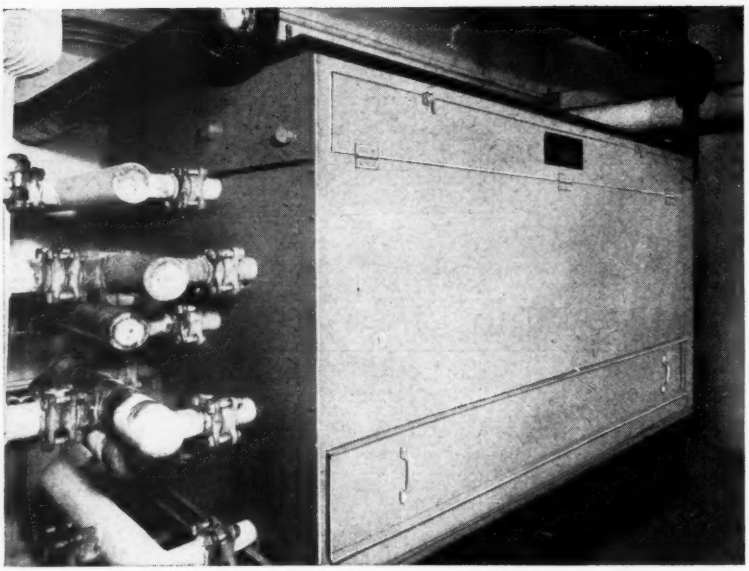
Presented for the first time in conveniently bound desk reference size, uniform with the other four volumes of the National Fire Codes also published by the NFPA, the 1947 National Electrical Code is a book that almost anyone using electricity commercially would like to know about. Copies are available for $2.00 from the Association which is located at 60 Batterymarch St., Boston 10, Mass.

Standard Brands Inc. has announced the appointment of A. C. Foster to the position of Chief Engineer. Mr. Foster has been with the organization since June, 1945, as Assistant Chief Engineer. A graduate of the University of Detroit, class of 1926, Mr. Foster has had a long and successful career as a Mechanical Engineer

The appointment of Eugene Somoff to the newly created post of technical service engineer was announced recently by the American Standards Association. Mr. Somoff, an electrical engineer with wide experience in Russia, Belgium, Great Britain, and the United States, will collect and supply technical information concerning American standards and those of other countries. He will conduct world wide surveys of standards available in any particular field for use by committees of the ASA and his service will also be available to its 2,000 company members and the Association's own engineering staff.

Fred A. Compton, formerly purchasing agent, has been appointed sales manager of


LADISH CO., CUDAHY, WISCONSIN
To Better Reflect the Expanded Scope of Our Operations and Products . . .
We announce a change in corporate name only
from
LADISH DROP FORGE CO.
to
LADISH CO.
CUDAHY • WISCONSIN
MILWAUKEE SUBURB
TO MARK PROGRESS
WATCH FOR AN IMPORTANT ANNOUNCEMENT IN THIS MAGAZINE DURING MARCH



Chilling Water or Liquids With Accurate Control of Temperature

Regardless of either variation in the cooling load or intermittent operation, the new Niagara Liquid Cooler holds the delivered temperature accurately at the required point. It will deliver fresh water at 33° F. constantly without danger of freezing damage and produces lower temperatures accurately in non-freezing chemical liquids and solution.

Capacity range in available models is from 24 to 465 gallons per minute. High capacity and fast chilling are provided in extremely compact space. The cooler is reliable and easy to maintain; all parts are accessible for cleaning; insulation is easily applied; operation is economical of power and refrigeration.

Write for Bulletin No. 100-PP

NIAGARA BLOWER COMPANY

Over 30 Years' Experience in Industrial Air Engineering

405 Lexington Ave. NEW YORK 17, N. Y.

Field Engineering Offices in Principal Cities

INDUSTRIAL COOLING HEATING • DRYING

NIAGARA

HUMIDIFYING • AIR ENGINEERING EQUIPMENT

The Detroit Edison Co., it has just been announced. Chester F. Ogden, formerly assistant purchasing agent, has been appointed purchasing agent to succeed Mr. Compton. Angus D. McLay, who has held the position of vice president and sales manager since the retirement in 1943 of Miss Sarah M. Sheridan, continues as vice president.

Obituaries

FREDERICK DAVID POTTER

FREDERICK DAVID POTTER, 88, retired electrical engineer and an associate of Thomas A. Edison in the development of electrical lighting facilities in New York City, died at his home in Linden, N.J., recently.

Mr. Potter was graduated as an engineer from the University of Maine in 1879—the year Mr. Edison perfected his incandescent lamp. He began work in June, 1882, for the Edison Isolated Lighting Co., of New York, in charge of installing light and power units in hotels, theaters, factories and public buildings which generated their own power current.

Mr. Potter laid out the pole line for the first electric light plant in Roselle, N.J., in the spring of 1883 and drew up a plan for the first use of electricity in the palace of Japan's emperor.

In 1913 he helped organize the Combustion Controls Co., New York, serving as vice-president and engineer. He retired in 1930 but was active up to the time of his death with the invention of an optical pyrometer for reading boiler temperatures. He had secured a patent on the device through the United States Patent Office.

Mr. Potter was one of two survivors of twenty-eight men who in 1918 founded the Edison Pioneers—an organization of men who had aided Mr. Edison in his early enterprises. The other remaining member is Edwin W. Hammer, of South Orange, N.J., seventy-nine, who commutes daily to New York, where he is an active consulting engineer.

Mr. Potter was born in Bath, Maine, the son of the late David W. and Hulda Potter. Surviving Mr. Potter are two daughters, Misses Marjorie and Mary Potter, and two sons, John D. and Charles Potter.

CHARLES BURTON THWING

CHARLES BURTON THWING, Ph.D., pioneer in the field of pyrometry and president of the Thwing-Albert Instrument Co., Philadelphia, died December 12, 1946.

Born March 9, 1860, at Theresa, New York, Dr. Thwing was an eminent physicist and the holder of numerous patents in the field of thermo-electricity. A graduate of Northwestern University and the University of Bonn, Germany, Dr. Thwing was active in the field of education prior to entering business.

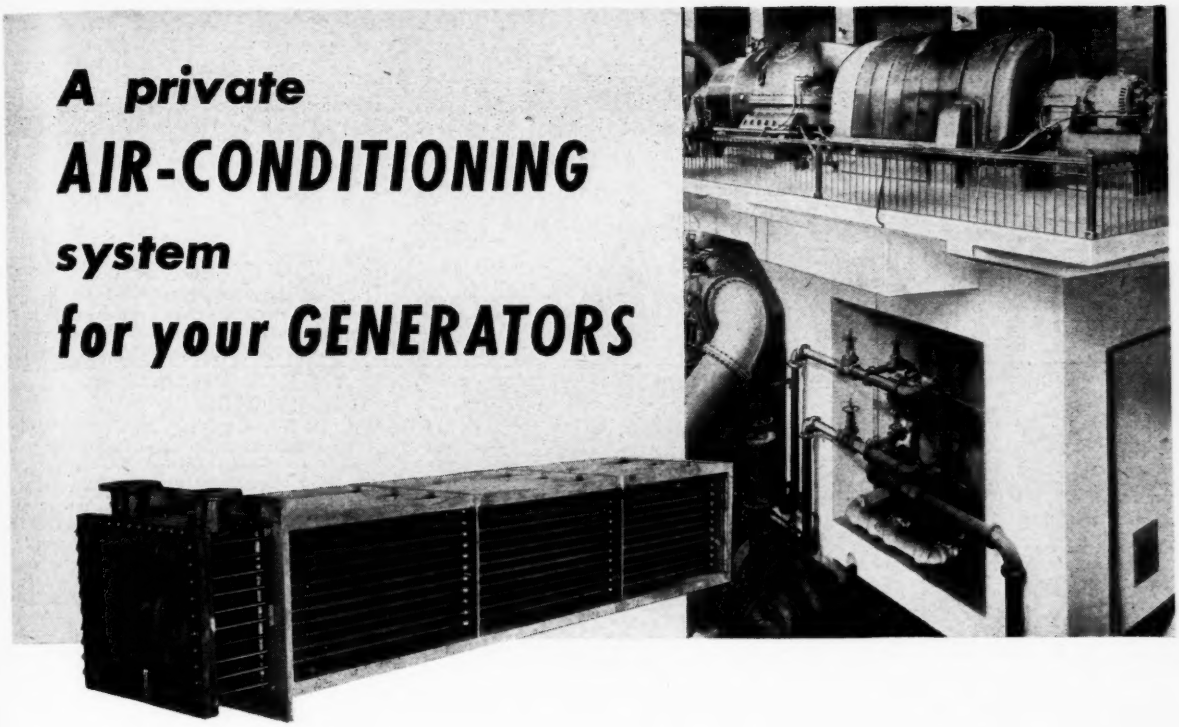
Included in Dr. Thwing's research was early work in the development of the electric light and wireless. He also formulated Thwing's Law on capacity.

PRESTON S. ARKWRIGHT

PRESTON S. ARKWRIGHT, chairman of the board of Georgia Power Co., died recently. For many years, Mr. Arkwright had been an outstanding figure in the electric light and power industry.

As a result of his association with H. M.

A private AIR-CONDITIONING system for your GENERATORS



G-R K-FIN Air Cooler

Some form of cooling arrangement for turbo-generator windings is not a luxury . . . it is a necessity.

But the forced draft circulation of engine room air or cellar air as a cooling medium results in the accumulation of undesirable dust in the windings.

In many hundreds of plants, this condition is avoided by circulating the air for generator windings in a closed circuit and cooled by a G-R K-Fin Air Cooler. The benefits of this system are many . . . quieter, cooler generator operation . . . reduction of fire hazard . . . lower maintenance expense and longer life of generator . . . reclamation of electrical heat energy by using condensate as the cooling medium.

G-R Air Coolers are in use with generators totaling well over 7,000,000 kw, ranging in size from 500 kw to 160,000 kw. Write for Bulletin 1219 describing the G-R K-Fin units and their distinctive features in detail.

THE GRISCOM-RUSSELL CO.

285 Madison Avenue **New York 17, N. Y.**

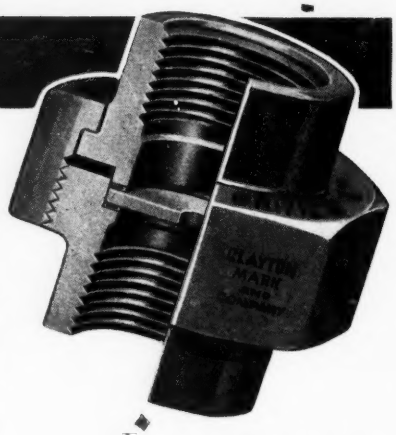
GR-181

GRISCOM-RUSSELL

Pioneers in Heat Transfer Apparatus

ORIFICE
FORGED STEEL UNIONS

Orifice

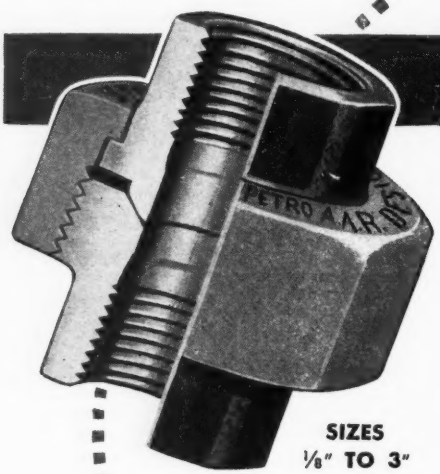


A SIMPLE, EASY-TO-HANDLE, MODERATELY PRICED, ORIFICE UNION.

Ideal for flow control of Steam, Oil, Ammonia, Water, Gas and Air. Also for metering and measuring. 600 lbs. S. W. P. or 2000 lbs. C. W. P. The ORIFICE plate is furnished in cold rolled 18-8 stainless steel. ORIFICE plate and gaskets are set in a groove of solid steel to safeguard against blowing of gaskets and resultant trouble. The ORIFICE union has extra heavy ends and nut with the nut threads permanently lubricated.

SIZES ¼" TO 3"

Petro



SIZES ⅛" TO 3"

AMERICA'S MOST UNIVERSALLY USED UNION

PETRO unions have integral steel to steel seats. Made to A. A. R. design. 600 lbs. S. W. P.-2000 lbs. C. W. P. Extra heavy ends and nut with nut threads that are permanently lubricated. The seats are machined and cold rolled.

A PARTIAL LIST OF PROVEN SERVICES

Pressures from a vacuum to 3000 lbs.: Temperatures from 100° below zero F. to 1000° above zero F.: On Steam, Gas, Air, Oil, Gasoline, Ammonia, Chemicals, and any service in which Steel or Wrought Iron Pipe is Used.

ORIGINATORS AND PIONEERS OF FORGED STEEL UNIONS SINCE 1912

WRITE FOR PAMPHLET AM-67 • ORDER BY TRADE NAME FROM YOUR JOBBER

CLAYTON MARK & COMPANY
1900 DEMPSTER STREET • EVANSTON, ILLINOIS

Atkinson, one of the pioneers in the development of the street railway system and of the electric light industry, Mr. Arkwright was elected president of the Georgia Railway & Electric Co. when that company was formed in 1902. He continued as president of its two successors—Georgia Railway & Power Co. and the Georgia Power Co.; the latter company was formed in 1927. He was elected chairman of the board in 1945.

Mr. Arkwright also was president of the old National Electric Light Assn. and of the Association of Edison Electric Illuminating Companies. Another honor to be bestowed upon him came from his own company when it named its new Macon, Ga. plant for him and called it Plant Arkwright.

E. H. JEFFORDS

E. H. JEFFORDS, recent Director of Raybestos-Manhattan, Inc., and General Manager of General Asbestos & Rubber Division, North Charleston, S.C., died December 12 at his home in Charleston, S.C. at the age of 71. He was unmarried.

Mr. Jeffords graduated from the Citadel, a southern military institute and worked for Charleston banks and business houses before taking his first job as bookkeeper with the General Asbestos & Rubber Co. on November 15, 1917. In this position he installed the company's first cost system. In 1927 he became vice-president and general manager of the company which in 1929 merged with the Manhattan Rubber Mfg. Company and other companies to form Raybestos-Manhattan, Inc.

Mr. Jeffords was succeeded by A. F. Heinsohn as General Manager.

MANUFACTURERS' *News*

GE's NEW WIRE AND CABLE DIVISION

A. W. GILMORE has been appointed manager of a new General Electric wire and cable division. The new division is a consolidation of the former York (Pa.) wire and cable division and the Bridgeport wire and cable division.

Mr. Gilmore has named the following men to assist him in the new division: M. H. Owen as manager of the York sales section; A. E. Newman as manager of the Bridgeport sales section; C. O. Hull as engineer; S. T. Powell as manager of manufacturing; and A. Hillman as accountant.

LINK-BELT ESTABLISHES OFFICE IN MILWAUKEE

LINK-BELT CO., Chicago, manufacturers of materials handling and mechanical power transmission machinery, announce the opening of a sales office in Milwaukee, Wisconsin, in the Century Building at 808 North Third St., in order to be able to serve customers in Wisconsin with greater facility. Postal zone 3; telephone Broadway 1674. Mr. William Hufnagel, district sales manager, is in charge of the new office, assisted by H. B. Johnson and F. E. Sweeney.

A portion of the sales territory falling within the scope of the new office has in reality been served by Mr. Hufnagel for a number of years from the company's Pershing Road plant in Chicago.

PERMUTIT NAMES FOUR VICE-PRESIDENTS

FOUR EXECUTIVES of The Permutit Co. have been elected Vice-Presidents, it was an-

It's PEABODY for Everybody:

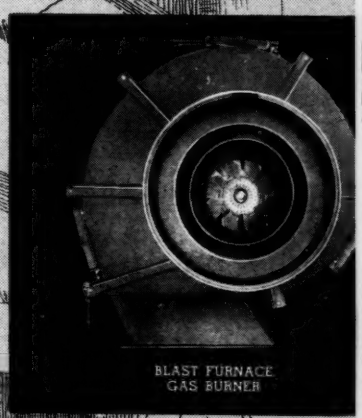
Burn OIL GAS COAL } SINGLY —OR— IN ANY COMBINATION

Power plant engineers are quick to appreciate the advantages of Peabody combustion equipment . . . of Peabody concentration and specialization in the field of combustion engineering through the years . . . of Peabody "know-how" and advanced design.

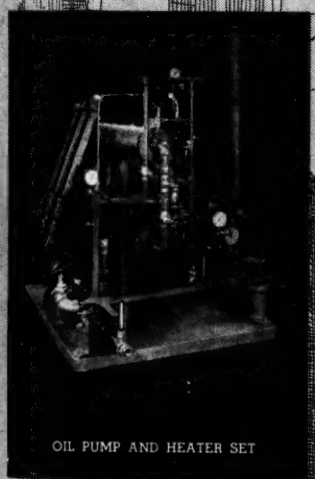
Remember, "It's Peabody for Everybody" every time. Let a Peabody engineer help you select, from the wide variety built, the equipment best suited to your needs.

REFINERY BURNER FOR GAS AND OIL

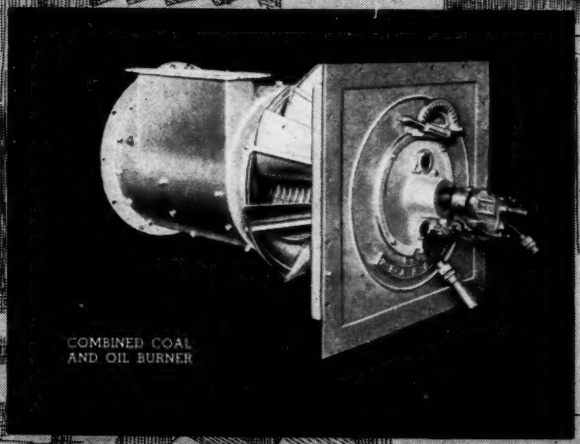
COMBINED GAS AND OIL BURNER



BLAST FURNACE GAS BURNER



OIL PUMP AND HEATER SET



COMBINED COAL AND OIL BURNER

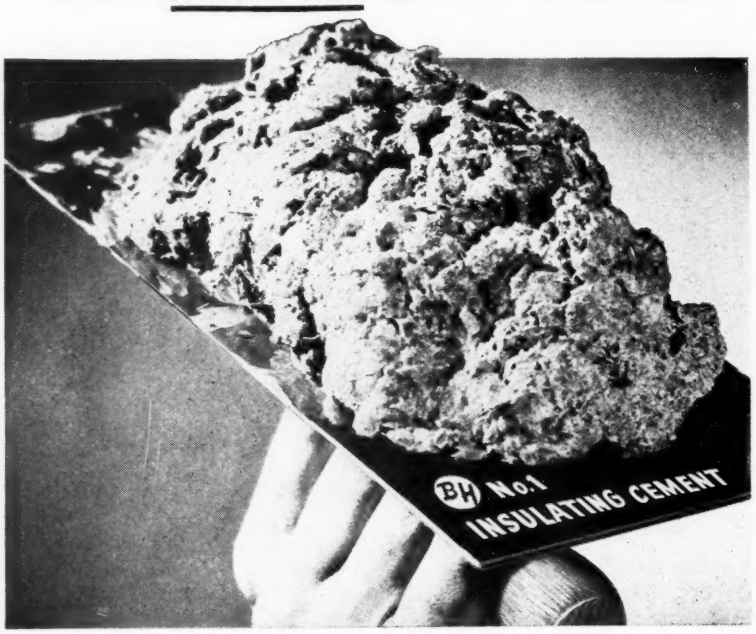
PEABODY

580 FIFTH AVENUE • NEW YORK

OFFICES IN PRINCIPAL CITIES

IT GOES ON *TO STAY!*

AND *INSULATES* UP TO 1800° F.



SIMPLY add water, mix and you're ready to do a fast-covering, efficient job with Baldwin Hill No. 1 *Insulating* Cement. To save time for your maintenance men, it sticks *instantly*—does not slide off bottom-surfaces or roll up behind the trowel. To save btu's *for you*, it's compounded of finely nodulated *black* Rockwool—a 3-inch application, for example, reduces 800°F surface temperature to 158°F. Important, too, B-H No. 1 takes expansion and contraction of the insulated surface in stride—without peeling or cracking. And, a special rust inhibitor prevents corrosion, insures a permanent bond even when applied while the surface is hot.

It will pay you to put B-H No. 1 Cement to work on valves, fittings and other irregular surfaces where heat loss is costing you money. Packed in convenient 50-pound multi-wall bags ready for instant use. The coupon brings descriptive literature and a working sample.

Baldwin-Hill

Specialist in Thermal Insulation

SEND ME a sample of B-H No. 1 Insulating Cement and the B-H data book "Industrial Insulation".

Baldwin-Hill Co., 515 Breunig Ave., Trenton 2, N. J.

NAME..... POSITION.....

FIRM.....

ADDRESS.....

CITY.....ZONE....STATE.....

DEPARTMENT OF TECHNOLOGY
BUFFALO PUBLIC LIBRARY

nounced recently. They are: J. D. Yoder, a chemical engineer graduate of the University of Michigan, who was previously with Cochrane Corp. as Vice President and General Manager. He joined Permutit on February 24, 1936, and has been Manager of the Boiler Feedwater Division.

D. J. Saunders, Vice-President of the Manufacturer's Association of Water Works and Sewage and member of the Association's Board of Governors, who came to Permutit March 16, 1920. Since January, 1938, he has held the position of Manager of Industrial Sales.

G. N. Proctor, a graduate mechanical engineer of Drexel Institute, who continued his studies at New York University's Graduate School of Business. He was associated with Thomas A. Edison, Inc., for fifteen years, acting during the last two years of that time as General Manager of the E-Mark Battery Division. Mr. Proctor come to Permutit December 16, 1944, as Manager of Manufacturing.

H. L. Beohner holds the degree of sanitary engineer from the Massachusetts Institute of Technology. He came to Permutit on June 23, 1930—immediately after receiving his degree. Mr. Beohner was appointed Technical Manager April 16, 1946.

REEVES PULLEY OPENS PHILADELPHIA OFFICE

THE REEVES PULLEY CO. is establishing its own Philadelphia Office.

The location will be: Reeves Pulley Co., Wilford Building, 33rd & Arch Streets, Philadelphia 4, Pa. Phones: EVergreen 6-8831, 6-8832.

Philip C. Talbot has been appointed manager of this new branch office, and he will be assisted by William A. McCosh. Both men are graduate engineers and have been directly connected with the engineering and sale of Reeves Variable Speed Control Equipment for many years and are capable of giving expert engineering service and advice.

NO GENERAL PRICE RISE FROM G.E.

EMPHASIZING that the General Electric Co. is not making a general "across the board" price increase, Charles E. Wilson, G-E President, said recently that each of the company's 200,000 products has been or is being studied separately "in an attempt to restore something like the normal balance between costs and selling prices."

DAMPNEY'S RESEARCH PROGRAM EXPANDS

THE DAMPNEY CO. of America announces the recent resignation of C. J. Hunter as Technical Director, and concurrently its plans to assign to its engineering consultants, Arthur D. Little, Inc. responsibility for a greatly enlarged research and development program. Mr. Hunter, after many years' association with The Dampney Co. is establishing an engineering sales agency for the distribution of power and mechanical equipment and materials throughout the New England area.

GRAVER EXPANDS OPERATIONS IN SOUTH-WEST

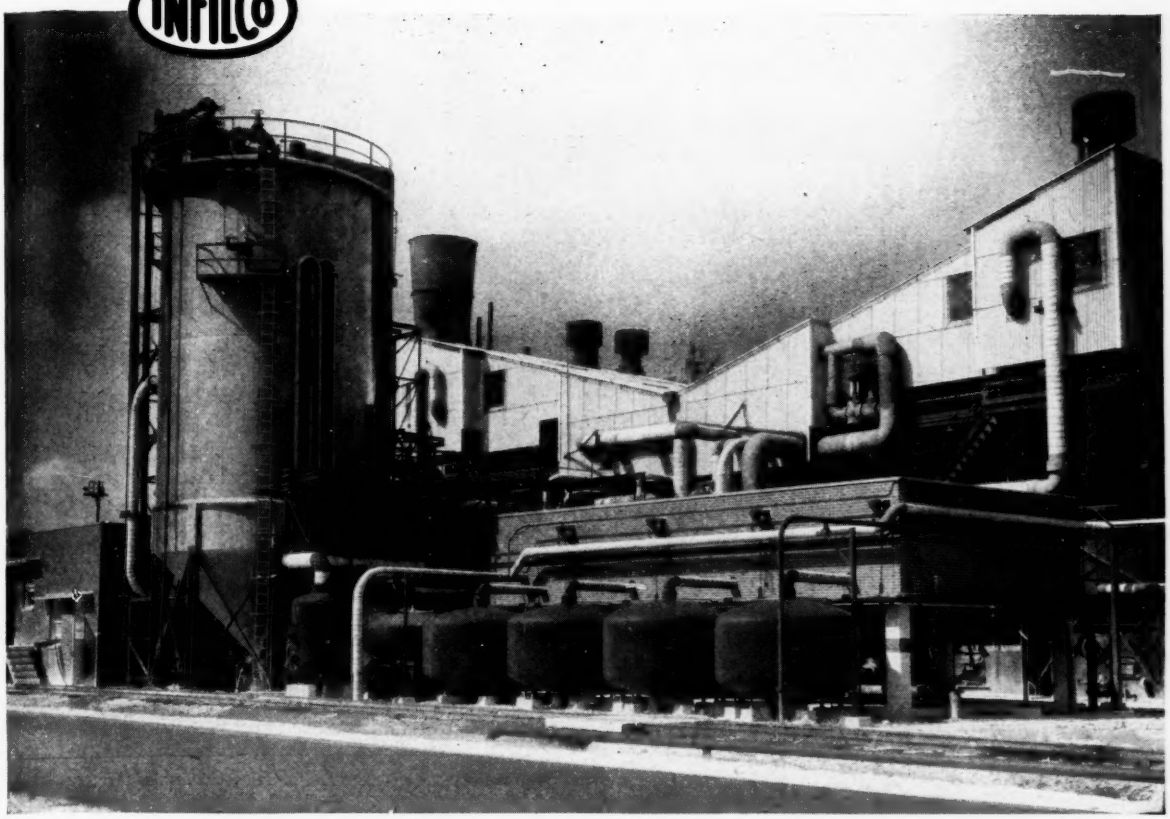
THE GRAVER Tank & Mfg. Co., Inc., East Chicago, Ind., recently announced the addition of a new southwestern division, the Banks Moreland Co., Houston, Texas.

The Banks Moreland Co. having for years been engaged in the varied types of tank and field erection work, and ideally suited by location to the greater petroleum producing areas, offered an ideal opportunity to combine forces to better serve the petroleum industry.

During previous years Graver, although long established in the southwest, had been somewhat limited in its operations throughout the Gulf Coast States. To offset these limitations, Hubert Smith established and organized an office for Graver in Port Arthur, Texas which enabled him to maintain direct supervision over all field erection work and provided a better opportunity to follow sales work in the gulf area. The steadily increasing volume of field erection work has long necessitated the need for a fabricating plant, and Houston,

XUM

INFILCO



INSTALLED WHEN BUTADIENE PRODUCTION WAS A "MUST"—

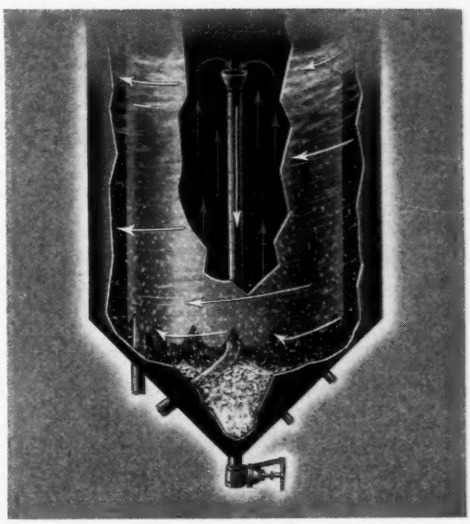
this 500,000 lb. per hour deaerating Hot-Flow Softener continues to make record refinery runs possible.

Handling a high silica water which, used untreated, would cause plenty of boiler room grief, this Hot-Flow Softener makes possible the continuous, trouble-free boiler operation so necessary to high production quotas.

Large or small, Infilco Hot-Flow Softeners incorporate design features which assure maximum treatment results with minimum attendance and overall operating costs.

If water—for boiler feed or other purposes—is one of your production "bottlenecks", it will pay you to find out what Infilco equipment can do for you in your plant.

When would you like to have one of our engineers call? INFILCO Inc., 325 West 25th Place, Chicago 16, Illinois.



It's the *internal* design that produces *better* chemical mixing, *better* solids separation and *better* sedimentation in the Hot-Flow Tank.

Thorough mixing of chemicals and thorough sedimentation in this tank always insure an adequate volume of properly treated feed water ahead of the filters.

CONSULT INFILCO — FIRST IN WATER AND TRADE WASTE TREATMENT

The Secret of DART UNION Superiority

Bronze seats precision-ground to meet in a true ball joint insure a drop-tight connection without heavy wrenching. Uninjured in fitting, Dart Unions may be uncoupled easily—used over and over again. Bodies and nuts are made of high-test air-refined malleable iron—are practically indestructible.

Ask your supplier to demonstrate Dart's unique money-saving features.

DART UNIONS

E. M. DART MFG. COMPANY

PROVIDENCE 5, RHODE ISLAND

Texas was chosen as the best possible location for this expansion of Graver sales, service and fabrication facilities.

Of interest to the friends and business associates of the Banks Moreland Co. is the fact that the former owner, Banks Moreland, has been named Vice President of Graver Tank & Mfg. Co., Inc., and will continue to direct the operations of this new division. Associated with Mr. Moreland, as in the past, are Mr. Allen, Mr. Arnold, Miss Lilly, who have worked closely with Mr. Moreland for many years.

BRASS DIE CASTING COMPANY FORMED

BLUE RIDGE Pressure Castings, Inc., will commence operations early in 1947 in Lehighton, Pa. The new company's plant, located adjacent to the Lehighton Airport, will operate high pressure die casting machines exclusively on production of brass castings, mainly for the plumbing and hardware trade.

Thomas C. Wilson, as manager, and Allen B. Behler, as superintendent, will head the Blue Ridge Co.; Mr. Behler working chiefly on alloying and die casting problems. Mr. Wilson, a metallurgist, will continue to concern himself with development work on die casting alloys and die materials.

INDEPENDENT TOOL ANNOUNCES EXPANSION

INDEPENDENT PNEUMATIC TOOL Co., Chicago, announces a $1,000,000 expansion of its main works at Aurora, Ill.

Site for the expansion has been cleared adjacent to the company's main plant, according to Neil C. Hurley, Jr., president, and construction of the annex, which will provide 85,000 square feet of additional floor space for production purposes, will begin shortly.

PA. FLEXIBLE TUBING ELECTS RONAN

THE BOARD of Directors of the Pennsylvania Flexible Metallic Tubing Co., at a special meeting recently, elected Eugene J. Ronan to the permanent post of executive vice-president of the company.

Mr. Ronan had been acting in that capacity since his firm, Associated Consultants and Co., was retained last February to reorganize the company. The board commended Mr. Ronan's administration of the company's affairs since he took over the operation of the plant.

Mr. Ronan announced that he would start a tour of the company's branches in the South and Middle West and would spend a week on the Coast surveying the Pacific industrial area with a view toward setting up direct factory representation in that region.

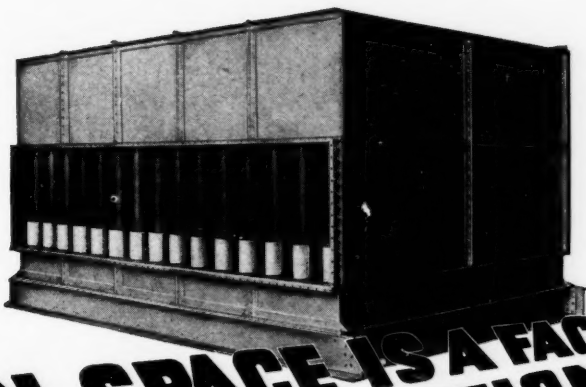
WELLBORN SUPERINTENDENT OF G.E. METALLURGY

APPOINTMENT of Abner B. Wellborn as superintendent of the Metallurgy Division of the General Electric Chemical Department was announced recently.

Mr. Wellborn is a graduate of Vanderbilt University in 1928. In 1935 Mr. Wellborn became associated with the Company's General Office and the following year joined the wage rate and planning section of the Schenectady Works. He was made supervisor of wage rate, production and planning in the General Electric Plant at Ft. Edward, N.Y., in 1942 and was named assistant to the superintendent of the Carbon Products Manufacturing Division in 1945.

Leeds and Northrup Co. has appointed Geare-Marston, Inc., New York and Philadelphia agency, to handle its publicity and public relations.

Manhattan Rubber Division of Raybestos-Manhattan, Inc., Passaic, N.J., has announced that Joseph Glenn & Sons, Clifton Heights, Pa., will now represent them in the Philadelphia area. The Glenn organization will carry a stock of conveyor, power transmission, V-belts and hose of all types. This warehouse stock and a factory stock less than 100 miles



WHEN SPACE IS A FACTOR IN DUST COLLECTION

To the many plants faced with meeting severe conditions of local dust ordinances and yet lacking suitable space for a conventional dust collector installation, the following examples of Thermix Tubular installations will provide food for thought:

● In a 125,000 lbs. per hour unit, a Thermix Tubular was installed at the bottom of the tubular air preheater . . . *in the same floor area* . . . using the preheater hoppers for the dust collector.

● A Thermix Tubular Dust Collector was installed *in the bell* of an 8′ diameter stack, handling a 300,000 lb. per hour pulverized fuel boiler.

● In a large paper mill using five pulverized fuel boilers, designs of which did not include provisions for a dust collector, Thermix Tubular Collectors were successfully installed.

These and many others are testimony to the minimum space requirements of Thermix Tubular Dust Collectors, available in extremely compact, easily installed six and nine inch diameter tubes . . . their high efficiency is an established fact.

Write for our suggestions for solving your dust collection problems.

●

THE THERMIX CORPORATION

Project and Sales Engineers

First National Bank Bldg. **Greenwich, Conn.**

PRAT-DANIEL CORPORATION

EAST PORT CHESTER, CONN.

NEW SAFETY IN GASKETS

"Flexitallic" GASKETS
How Flexitallic Precision Brings a New Degree of Safety
for sealing steam and other fluids under pressure
FLEXITALLIC
8th & Bailey Sts.

WILL YOU READ ABOUT IT?

This new little book speaks of safe-sealing for fluids under pressure with the plain honesty the subject of safety deserves.

It tells with sketches and few words how the "Flexitallic" art which established itself in wide use through safe performance has now put safety on a new level.

You are not asked to abandon one theory and accept another. The book deals with a record of performance and identifies the practices that make the record possible. You are urged to believe only what pre-testing can—and will—prove to you.

We'll send you a copy

A post-card will serve but you will help us in record-keeping by giving us the name of your company and your title or department.

Originators of Spiral-Wound Gasket Construction

"Flexitallic"

Gaskets of this name are manufactured only by

FLEXITALLIC GASKET COMPANY
8th and Bailey Streets Camden, N. J.

from Philadelphia is expected to prove advantageous to customers in the district.

According to an announcement from the company, B. Schroeder is retiring from active participation in the work of Sargent and Lundy, effective December 31, 1946, after more than forty-three years of service with the office. L. Skog will succeed Mr. Schroeder as Senior Partner and Chief Engineer.

MANUFACTURERS' *Personals*

Appointment of John C. Campbell as Manager of Industrial Engine Sales and of James W. Brown as Advertising Manager was announced recently by Detroit Diesel Engine Division of General Motors.

Emmett W. Hines has been appointed manager of the New York zone of the Otis Elevator Co., effective December 1, it was announced recently. The zone includes metropolitan New York City and nearby counties in New York and New Jersey. Mr. Hines, who has been manager of the company's Buffalo zone nine years, replaces George A. Mount, who is retiring after 34 years with the Otis rganization, the past six as manager of the New York zone.

Louis R. Caplan, Washington, D.C., representative of Hagan Corp. until he went into the Army, has returned to his post to represent Hagan, Hall Laboratories and Calgon, Inc. interests, it has just been announced. The post was filled in his absence by George H. Larkin, who has taken over the company's Cincinnati office.

Harold S. Silver has been named general patent attorney in charge of the patent department, legal division, of the Allis-Chalmers Mfg. Co., Milwaukee, Wis., according to a recent announcement. He succeeds the late J. J. Kane.

Ray E. Hoffman, plant manager for the past 27 years of the Hannibal, Mo., plant of Universal Atlas Cement Co., United States Steel Corp. subsidiary, retired recently after 40 years of service at the same plant. Appointed to succeed Mr. Hoffman, effective Dec. 1, is Richard D. Mayne, former mine and quarry superintendent and latterly assistant plant manager at Hannibal.

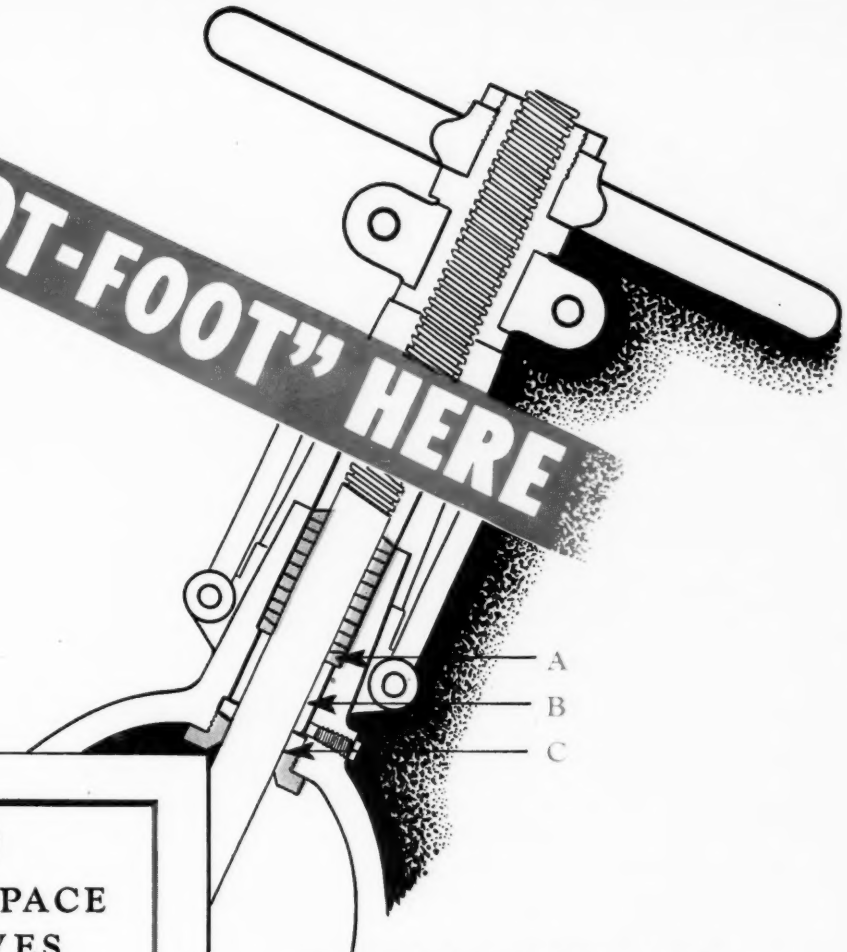
United States Steel Supply Co. recently announced appointment of Thomas T. Dickson as manager of the specialty and machinery division, general sales department, with headquarters in Chicago. Mr. Dickson has been associated with this U. S. Steel subsidiary company continuously since December, 1916, during which time he occupied positions chiefly in the purchasing and sales departments.

Alfred E. Stacey, Jr., air conditioning pioneer and one of the seven founders of Carrier Corp., is rejoining that organization as of December 1st, according to a recent announcement. Mr. Stacey, who has been on active duty in the United States Navy with the rank of captain, will be process consultant to the sales division. In this capacity, he will devote major attention to the application of temperature and humidity control to industry.

Appointments of V. J. Rauer, G. M. Patton and R. G. Mussen to supervisory manufacturing positions in the Metallurgy Division of the General Electric Department were announced recently. Mr. Rauer was named Supervisor of Production, Mr. Patton, Supervisor of Planning & Wage Rate and Mr. Mussen, Supervisor of Test and Inspection.

Robert W. Larson has been appointed Administrative Assistant to the Director of the

NO "HOT-FOOT" HERE

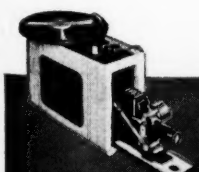


OIC

SETS THE PACE IN VALVES

MANY a steel valve has been quickly ruined by high-temperature fluids or gases near the foot of the stuffing-box. Heat can literally "bake" the packing to the stem and the stuffing box . . . causing galling and seizing. Now OIC valve designers have solved this problem by lifting the foot of the stuffing box farther away from the hot valve body . . . to keep the packing cool and in good condition.

As you can see in the picture above, this efficient, new OIC steel valve design is as simple as A, B, C. Packing is separated from the hot valve body by a heavy, alloy-steel ring bushing (A) . . . a condensing chamber (B) . . . and a pressure-tight back-seat bushing (C). The packing stays cool . . . stays on the job to assure you long, economical, trouble-free valve service.



See new film

For latest information on steel valves, see the new OIC sound slidefilm. If you'd like a "showing" for your personnel, please mail reservation request now to The Ohio Injector Company—Wadsworth, Ohio.

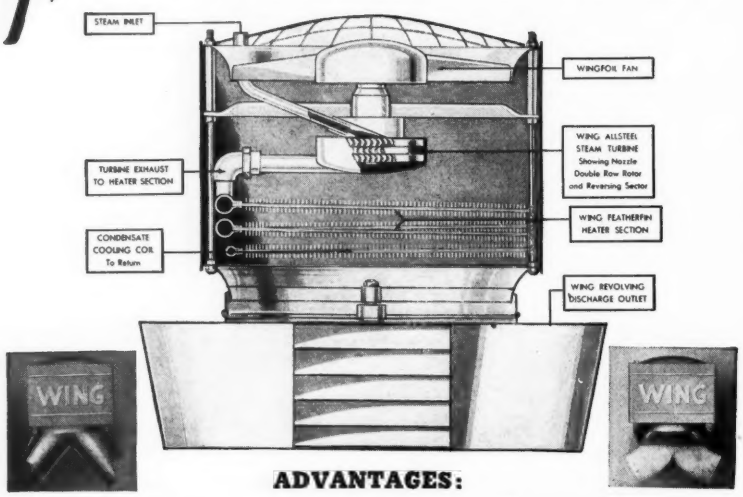
OIC VALVES

STEEL - IRON - BRONZE

O-147-8

Another WING "First"!

the Wing Turbine Revolving Unit Heater


STEAM INLET
WINGFOIL FAN
WING ALLSTEEL STEAM TURBINE Showing Nozzle Double Row Rotor and Reversing Sector
TURBINE EXHAUST TO HEATER SECTION
WING FEATHERFIN HEATER SECTION
CONDENSATE COOLING COIL To Return
WING REVOLVING DISCHARGE OUTLET
WING
WING

ADVANTAGES:

- **No electric motor**
- **Source of heat is also source of power**
- **No back pressure**
- **No packing**
- **No traps**
- **No pressurestat needed. Fan stops when steam pressure stops**

This new product is the logical result of constant improvements in two specialized lines of equipment pioneered by L. J. Wing Mfg. Co.

The first Wing turbine was built as an integral part of the Wing forced draft blower 40 years ago. The first lightweight-suspended downward-discharge unit heater was introduced by Wing 25 years ago. The patented revolving discharge outlet was introduced in 1935. The Wing Turbine Driven Revolving Unit Heater, now offered, combines all three.

Powered by the new Wing Allsteel Steam Turbine which operates *at any* pressure, the steam which propels the fan is exhausted into the heater section and used to heat the air—thus eliminating motor and electric power.

There is no back pressure on the turbine, eliminating the need of power-absorbing, troublesome packing. No steam traps are used.

The Revolving Discharge Outlets distribute the heat continuously in constantly changing directions, over, around and under obstructions, into out-of-the-way corners.

Write for Bulletin

L. J. Wing Mfg. Co. 64 Seventh Ave. New York 11, N. Y.

Factories: Newark, N. J. and Montreal, Canada

Wing

General Electric Research Laboratory at Schenectady, it has just been announced.

William E. Herb has been appointed general sales manager in charge of sales and advertising for Gifford-Wood Co., effective Jan. 6. Walter G. Engler, formerly Western district manager, has been made Eastern district manager.

Appointment of Francis J. Wakem as Vice President of Johns-Manville Sales Corp. was announced recently. Mr. Wakem will also continue as Merchandise Manager of the Industrial Products Division. Mr. Wakem began his association with Johns-Manville in 1921 and is a member of the firm's Quarter Century Club. He is a graduate of Exeter Academy and Yale University.

New ENGINEERING BOOKS

The Efficient Use of Fuel, prepared under the direction of the Education Sub-Committee of the Fuel Efficiency Committee of the Ministry of Fuel and Power of Great Britain. The foreword for the American Edition is prepared by John C. Olsen, Ph.D., of the Polytechnic Institute of Brooklyn, New York. Copyright 1945; size 5¾ by 8¾ in.; 807 pages; hard cloth binding; published in America by The Chemical Publishing Co., Inc., Brooklyn, N.Y. Price $8.50.

The book is a comprehensive textbook on fuels and their efficient utilization, for the use of students and technical men in industry. Although this text was prepared for use in England and the composition of British fuels and the descriptions of equipment are given without much reference to American practice, the bulk of the principles and industrial methods discussed is equally adapted to American practice. Whatever essential differences exist can readily be ascertained by reference to American technical literature, which fully covers the subject.

Several chapters on industrial fuels, considering coal, coal derivatives, the storage of coal, chemical principles of combustion and gasification are given. The book then devotes a number of chapters to the more practical use of fuels in industry such as that of steam generation, heat transmission, flow of fluids, various methods of firing fuel and the operation of boilers, feedwater purification, boiler efficiency and testing, gas producers, various types of furnaces, refractory and insulating materials, and closes with chapters on instruments, sampling solid fuels, gases and analysis of solid fuels, and a chapter on the selection of fuels for industrial purposes.

Uncle Sam's Billion Dollar Baby, by Frederick L. Collins. Copyright 1945; 5¾ by 8¾ in.; 175 pages; hard cloth binding; published by G. P. Putnam's Sons, 2 West 45th Street, New York, N.Y. Price $2.50.

This extremely interesting book, written in story form, explains for the average citizen the social and commercial experiment in government ownership known as the Tennessee Valley Authority, which has already cost over 800,000,000 dollars and will shortly, according to its director, have cost a billion dollars of the taxpayer's money. The author is not nor does he claim to be an authority on electricity or the production of electric power, but he has made a rather exhaustive study of the conditions surrounding the Tennessee Valley, and with the help of officials of TVA has brought up a number of questions for discussion which are put down in a conversational style which is a delight to read. The author raises such questions as "Is the TVA in fact the brilliant success it claims to be?" "Is the TVA democracy on the march as its director says it is or is it democracy on the run?" "Are the beautiful TVA skyscraper dams the blessings to the community that they appear to be in their photographs or are they real menaces?" "Has the public been misled as to the financial condition of the TVA?" "Does the public know, that the TVA

COPPER ALLOY BULLETIN

MARINE AND POWER EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared by Bridgeport Brass Company "Bridgeport" *Headquarters for BRASS, BRONZE, and COPPER*

ANTICIPATE FUTURE CONDITIONS

Extending Condenser Tube Life

How are power plant operators meeting the dual challenge to produce more power and meet higher costs? The answer is being sought through higher efficiency.

There are many plants that are using condenser tubes of Admiralty composition installed during the war, and are looking forward to a complete retubing job in the near future. Now they can select the alloy which will stand up under present-day operating conditions, since they are not restricted as to alloy.

Other plants are going ahead with their modernization and expansion programs in spite of unexpectedly high construction costs and substantial price advances in equipment. Worn-out plants are inadequate to handle existing requirements for electric service. Operators foresee good business conditions for years to come and are making plans which will take care of their present and future requirements.

New plants which anticipate future needs should use only condenser tubes which will adequately withstand the more severe operating conditions that are also predicted for the future. As a matter of fact, the best tubes are the cheapest from the standpoint of hours of service obtained from them.

Selecting The Most Serviceable Alloy

It is unwise to assume that an alloy which has given good service in the past will be satisfactory for present and future conditions.

The history of a number of installations has revealed that condensers which were intermittently used over a period of many years performed in a very satisfactory manner, although toward the end of the useful tube life the continuity of operation may have been slowly increasing with rest periods becoming shorter. Replacements with new tubes which were then used for almost continuous service, with very short rest periods, have often led to increased tube failure. It appears that this type of difficulty will continue to be quite prevalent until the time when such a condenser is again used for intermittent service.

If it is necessary to change the condenser from intermittent to continuous operation, it will be necessary to consider a change of condenser tube alloy, since a material which will operate satisfactorily under intermittent service may not necessarily operate satisfactorily under continuous operation.

In some seaboard plants Admiralty has given very satisfactory service when used in an intermittent manner, but has not come up to expectations when pressed for continuous use. Aluminum Brass, however, has given a better account of itself than Admiralty for continuous operation, other conditions being equal.

When selecting condenser tubes, one should take into account the operating changes which have occurred during the period that the present condenser tubing has been in operation. Has there been a change in the intake screen construction? Smaller holes or openings in the screens than in the tubes themselves help to retard the entrance of certain types of foreign matter into the tubes. Has there been less frequent cleaning of tubes? Proper cleaning done regularly will reduce pitting from foreign deposits. Removal of slime will increase heat transfer, hence efficiency. Has there been a change in pump capacity? Increased water velocity accelerates corrosion and may be responsible for impingement attack at the inlet end of the tubes. Has the condenser changed from intermittent to continuous service? Intermittent service often permits the deposit of a tenacious protective scale or film on the inside of the condenser tubes. Hence longer life expressed in number of service hours is to be expected.

Investigate More Corrosion-Resisting Alloys

It doesn't pay to gamble with the selection of condenser tube alloys; hence, Bridgeport Brass Company encourages operators to test, under service conditions, samples of the more corrosion-resistant condenser tubing such as Duronze IV* (arsenical aluminum bronze), Cuzinal (aluminum brass), and Cupro Nickel. This is the soundest kind of procedure before selecting an alloy for retubing. There is no substitute for experience when it comes to condenser tubing. Bridgeport has always realized the importance of corrosion research in connection with rendering best possible service to condenser tube customers, and fully intends to maintain that activity at a high level. Laboratory tests have proved the beneficial effects of alloying elements such as arsenic to Duronze IV and to our Copper-zinc alloys; aluminum and tin to brass; iron to cupro nickel. When such data are correlated with records kept by power plant operators, a great deal of time can be saved by determining which alloys probably will or will not work best under a given set of conditions.

Anticipate Tubing Requirements

The necessity for ordering condenser tubing early has been mentioned before and is important enough to bear repetition.

Operators planning new construction will find it very beneficial to order condenser tubing at the same time they place orders for equipment. If this is done, delays in condenser tube delivery will not hold up completion of the entire job.

There are other advantages in anticipating retubing requirements. By having enough tubing on hand when it is needed, operators can protect themselves against shutdowns due to premature tubing failure, and can schedule retubing operations more efficiently.

Bridgeport's Corrosion Research Laboratory and Technical Service Department are set up to help operators get the most out of their condenser tubing and choose more corrosion-resistant alloys for retubing. Contact them through the nearest Bridgeport Office. Make sure that you have Bridgeport's technical literature on condenser and heat exchanger tubing—the Condenser Tube Manual and Duplex Tubing Technical Bulletin No. 746.

*U. S. Pat. No. 2,093,380

BRIDGEPORT BRASS

BRIDGEPORT BRASS COMPANY, BRIDGEPORT 2, CONN. • *ESTABLISHED 1865*

CLEAR
Since 1907
THE PACESETTER FOR
Safety
Since 1907 SONDERGLASS has been setting the pace for safety in water column operation. Its double-layer construction gives extra resistance to inner heat and outer cold—minimizes danger of ugly cuts or blinded eyes from flying glass . . . Comes in two popular types illustrated. CLEAR for use where water column is well lighted—REFLECTING with red and white enamel background to make water level visible as a bull's eye.
A. W. CHESTERTON CO.
6 ASHLAND ST., EVERETT STATION, BOSTON 49, MASS.
Distributors in Principal Cities
REFLECTING
SONDERGLASS
"THE UNBREAKABLE GAUGE GLASS"
Order From Your Dealer or Directly From Us

STEAM CAN BE HANDLED ECONOMICALLY . . .

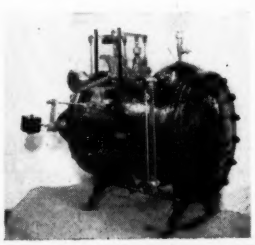
(on old or new systems)

Investigate the STERLING STEAM ECONOMY LIFTER !

Great Savings Are Being Made in Many Industries—Such As

Paper Mills — Leather Industries
Laundries — Textile Service

The STERLING system requires practically no steam to operate. Returns condensate often in excess of 300 degrees.



Sterling Engineering & Mfg. Corp.
(Templeton Mfg. Co.) 17 Business St
Hyde Park, 36 Massachusetts

doesn't pay any interest on the taxpayer's money it receives free gratis for nothing from the United States Treasury?" "Shouldn't the public know these things now before more TVA's are established all over the country and annual deficits are dumped onto the taxpayer's backs?"

The author's story is not one condemning the Tennessee Valley project but argues the questions from the standpoints of members of a family. In finishing his story the author comes to the conclusion that TVA is democracy on the march and ends with the admonition that the reader be fair about the whole undertaking.

The Chemical Formulary, Volume VII, by H. Bennett, Editor-in-Chief and the Board of Editors consisting of 59 specialists in the various industries. Copyright 1945; 5½ by 8¾ in.; 474 pages; hard cloth binding; published by the Chemical Publishing Co., Inc., 234 King Street, Brooklyn 31, N.Y. Price $6.00.

The Chemical Formulary, Volume VII, is a collection of timely, practical recipes for making thousands of products in many fields of

(Continued on Page 170)

HELPFUL BULLETINS

(Continued from Page 54)

works. Each section is well illustrated with views of the unit itself and also of the application of the unit; other applications and features are listed in panels. Two tables . . . principal dimensions and ratings . . . are accompanied by line drawings. The B. F. Goodrich Co.

45 **Asbestos Construction Handbook**—Here is one of the most complete booklets, on the use of corrugated asbestos in building construction, which has yet appeared. The 40 pages in this booklet are crammed with "how-to-do-it" information on methods of lapping, methods of fastening, staggered and straight methods of application, structural details, gutter details, etc. The illustrations are unusually well executed and appear on nearly every page. Other information given includes tables and data on the asbestos itself . . . its weight, length and area . . . and drawings, photos and tables of accessory equipment. Keasbey & Mattison Co.

46 **Pulsation Problems**—"The Effects and Corrections of Gas Pulsation Problems," is the title of a recently-issued 12-page Bulletin PD-1. The reasons for pulsation in gas-engine-driven compressors are explained and corrections for the troubles are suggested. Charts, line drawings and photographs are used to clarify many points in the discussion. The company's equipment is described briefly. The Fluor Corp., Ltd.

47 **Tools Catalog**—Wrenches, pipe cutters, tubing cutters, pipe vises, vises, saw vises and other tools are described in this 16-page catalog. Each of the tools is described in detail and tables of sizes and prices are included. Other price lists are given for tool parts. The booklet is bound in a heavy paper cover. Trimount Mfg. Co.

48 **Stock Pumps**—The use of stock pumps in paper and pulp mills is covered in this 8-page bulletin. Cross sectional view of the pump is presented and a wash drawing of the unit is used to point out the various parts. Four charts of head and friction loss in four sizes of pumps are presented and another chart of capacities is printed. Frederick Iron & Steel, Inc.

49 **Smoke Prevention**—"Smoke—Its Cause, Cost and Prevention . . . for Power and Heating Plants," is the title of a 16-page booklet issued recently by this company in the interest of smoke abatement. The booklet is arranged in logical fashion starting with "Causes" such as inefficient operation, inadequate and antiquated equipment and proceeding to the "Prevention of Smoke" which comprises the lion's share of the bulletin. The booklet is illustrated with line drawings and photographs. Perfex Corp.

50 **Air Filtration Manual**—"Air Filtration in Central Systems," is the title of this 24-page bulletin which is described as a manual for engineers and architects on the application of Dust-Stop filters. Many tables and charts on efficiencies, dimensions, ratings and resistance are given. Photographs show methods of installation and line drawings are used to portray typical installation details. Some of the installation photos are of the step-by-step type. Several pages on combined drawings and tabular materials give information on assemblies of various sizes. Another section covers maintenance of the units. Owens-Corning Fiberglas Corp.

LOOK TO THE FUSE LEADER FOR PRODUCTION PROGRESS

WARE HI-LAG *Renewable* FUSES

Wide Double Contact Surfaces— Spring Tension Locking of Links

WARE HI-LAG Fuses provide extra wide contact surfaces on both sides of links and stronger connections. Link connections are held firm and tight at all times by large arched spring steel washers and heavy studded bolt, which locks the links into the circuit.

Expansion and contraction of metals during *Off* and *On* periods compress links. This fluctuation causes loose contacts and oxidization in other fuses, which finally result in excessive heating and unnecessary blows. WARE HI-LAG construction keeps contacts permanently tight, thus insuring low resistance and longer fuse life.

WARE HI-LAG has many exclusive features in addition to the above; including the Link Design-Double Bridge Knife-Blade Assembly-Gas Vents and Simplified Construction, only 3 Parts. That is why it is known as the World's Best and Coolest Operating Fuse made.

Investigate at once! Start economizing by making it Standard Equipment.

Write for Brochure giving details of all the COOL FACTS, sizes and prices.

KNIFE-BLADE
250 VOLTS
600 VOLTS
70 to 600 AMPS.

FERRULE
250 VOLTS
600 VOLTS
3 to 60 AMPS.

APPROVED BY UNDERWRITERS' LABORATORIES

WARE Brothers 4450 W. LAKE ST. · · CHICAGO 24, ILL.

CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions dictated by space requirement or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

BOILERS

51 **Steam Generators**—Catalog almost completely devoted to cross-sectional drawings with accompanying listing of principal data of typical installations in rubber companies, steel works, sugar refineries, municipal plants, etc. Details of furnace water wall construction on inside back cover; 16 pages. Henry Vogt Machine Co., Inc.

52 **Double-Pass Boilers**—Bulletin RM-1 (6th edition); illustrates and describes this line of riveted or welded double-pass steel firebox boilers. Three full pages of dimensions, ratings and other details including dimensioned line diagrams; 8 pages. The Brownell Co.

53 **Boilers, Burners, Accessories**—Bulletin GC-10; condensed catalog of regular products for stationary power plants. Each class of equipment summarized and illustrated. Well illustrated with line drawings and photographs. Illustrations accompanied by brief descriptions; 12 pages. Combustion Engineering Co., Inc.

54 **Standardized Boilers**—Bulletin 746; 4 page bulletin presenting construction and operation information and ordering specifications for this company's Type M boilers. Bulletin illustrated, presents table of measurement and data. Springfield Boiler Co.

55 **Steam Generator**—Bulletin 119; company's Type S steam generator described and features of construction are pointed out. Folder well illustrated and dimensioned drawing and table of dimensions and sizes given. Union Iron Works.

PRIME MOVERS

56 **Axial Flow Impulse Turbine**—Bulletin S-107; six types described; data for estimates; applications; types, casings; wheels and blades; shafts, nozzles and bearings; overspeed stop and other governor features; lubrication; 8 pages. Terry Steam Turbine Co.

57 **Multi-Stage Turbine**—Bulletin SR-114; Casing, lagging, wheels and blades; shafts, nozzles, bearings; governors; speed changer or synchronizer; governor valve and steam strainer; lubrication; general; 10 pages. The Terry Steam Turbine Co.

58 **Steam Engines**—Bulletin No. 306; Engineering data; tabular material, descriptions; 8 pages. Troy Engine & Machine Co.

59 **Generating Sets**—Bulletin No. 108; General descriptions, typical installations, engineering data tables, details of construction, completely illustrated; 24 pages. Troy Engine & Machine Co.

60 **Stationary Diesel Engines**—Dependability, adaptability of Diesel power described and the first five applications pointed out. Its economical and simple design is stressed. Advantages of company's equipment brought out; exceptionally well illustrated; 24 pages. Enterprise Engine and Foundry Co.

AUXILIARIES, ACCESSORIES

61 **Strainers and Separators**—Bulletin 46-50; describes complete line of company's strainers and separators. Dimensions and price lists, dimensioned drawings and photographs; tables of sizes and complete description of applications, operation and design; 16 pages. American District Steam Co.

62 **Atomizing Deaerators**—Bulletin 4160; 3 color drawing illustrates description of principle of operation. Advantages of deaerators are described and illustrated; marine deaerators also covered; 20 pages. Cochrane Corp.

63 **Steam Condensers**—Bulletin 1461 "Steam Condensers"; exceptionally well illustrated with line drawings, charts and photographs. Large proportion of the catalog devoted to engineering information such as calculations of required surface, atmospheric relief valve sizes, tube characteristics, free dry air leakage, pressure-temperature conversion tables and tables of logarithms; 46 pages. C. H. Wheeler Mfg. Co.

64 **Condensate Return System**—Description of operation and possible savings accompanied by line diagram and description of how "Jet-Loop" works; typical installations pictured and described. Drawings and text shows proven results from experience of users. 2 page spread of drawings and table of dimensions; 16 pages. Cochrane Corp.

65 **Low Pressure Evaporators**—Description of L. P. evaporators; types of evaporator plants, listing of advantages of L. P. submerged tube evaporators. Line diagrams illustrate principles brought out in descriptions. Typical installations are considered and analyzed; 12 pages. Condenser Service and Engineering Co., Inc.

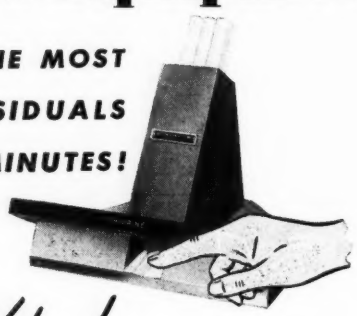
66 **Power and Industrial Equipment**—Bulletin Q-12; describes and illustrates company's equipment for power and industrial use—steam turbines, motors, generators, feedwater heaters, turbo-chargers, steam jet ejectors, centrifugal blowers. Exceptionally well illustrated; 20 pages. Elliott Co.

67 **Heat Exchanger**—This new bulletin describes the company's Twin G-Fin Section; Bulletin 1614; section characterized as universal heat exchanger. Bulletin tabulates 21 features and corresponding advantages, describes design and construction. Installation views shown, field reports included; 16 pages. The Griscom-Russell Co.

68 **Evaporators**—Bulletin 364 describes, illustrates evaporators for various capacities and pressures; contains sections of special interest to plant engineers and executives; includes explanation of functions of evaporators, benefits obtained

With Taylor Equipment

YOU CAN DETERMINE MOST BOILER WATER RESIDUALS IN ONE TO TWO MINUTES!



There's the Value!

YOU GET . . . *Speed* . . . with a simple, three-step operation!

YOU GET . . . *Simplicity* . . . no handling of fragile Nessler tubes!

YOU GET . . . *Accuracy* . . . liquid color standards carry an UNLIMITED guarantee against fading!

YOU GET . . . *Economy* . . . standard slides, for silica, chlorine, ammonia, pH, etc., may all be used on one single base!

YOU GET . . . *Durability* . . . sets are made of plastic, light in weight, extremely portable!

YOU GET . . . *Convenience* . . . no single standards to handle. Complete sets of color standards enclosed permanently in slides.

GET THIS BOOK!

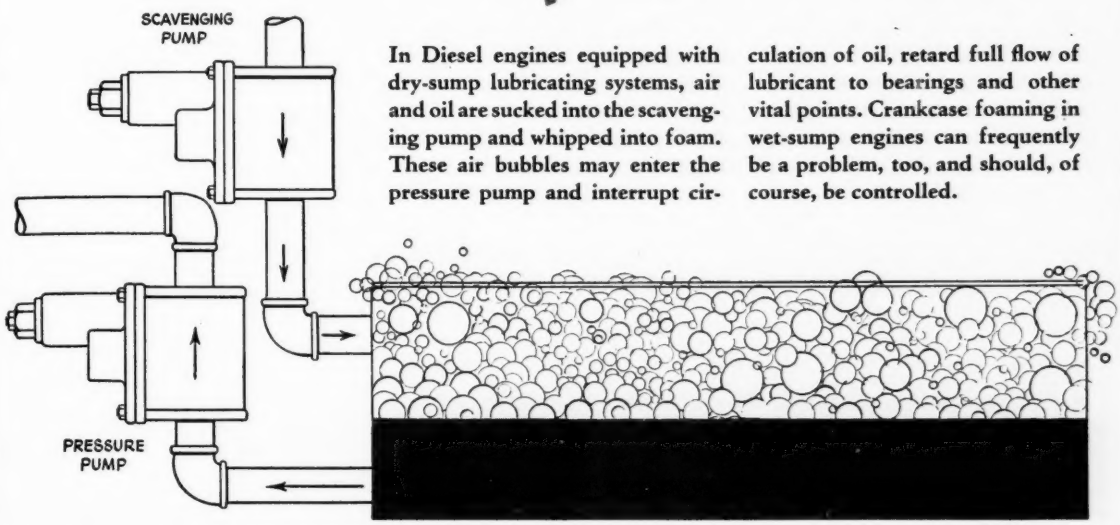
Ask for free copy of "Modern pH and Chlorine Control" . . . 88 pages give detailed information on Taylor methods and equipment . . . theory and application in 34 basic industries. Makes recommendations for many types of power plant needs. You can use it as a reference book. See your dealer or write direct to:

W. A. TAYLOR AND CO.

7301 YORK RD. • BALTIMORE-4, MD.

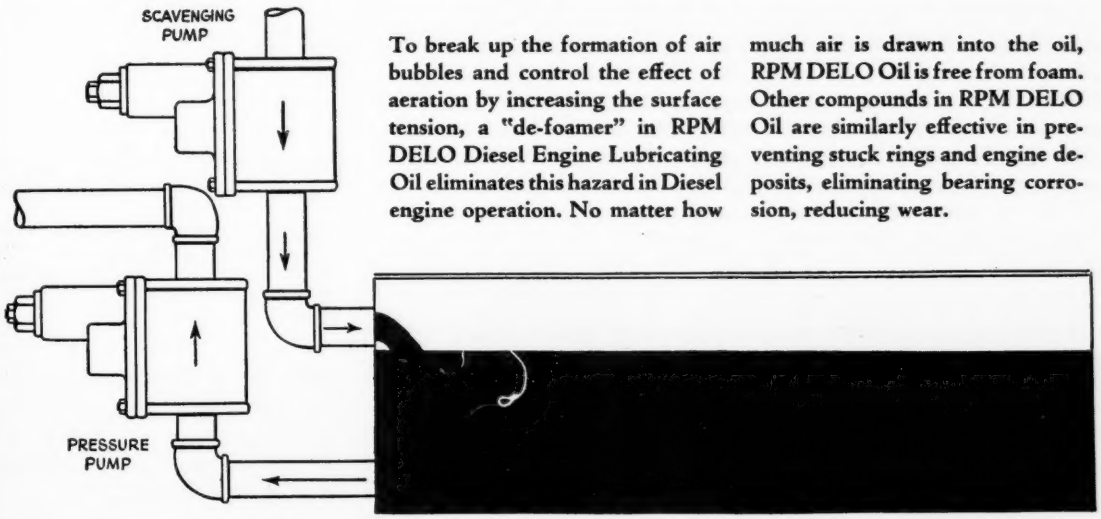
Diesel Engine DANGER points

AIR BUBBLES ENDANGER OIL CIRCULATION



In Diesel engines equipped with dry-sump lubricating systems, air and oil are sucked into the scavenging pump and whipped into foam. These air bubbles may enter the pressure pump and interrupt circulation of oil, retard full flow of lubricant to bearings and other vital points. Crankcase foaming in wet-sump engines can frequently be a problem, too, and should, of course, be controlled.

RPM DELO OIL PREVENTS CRANKCASE FOAMING



To break up the formation of air bubbles and control the effect of aeration by increasing the surface tension, a "de-foamer" in RPM DELO Diesel Engine Lubricating Oil eliminates this hazard in Diesel engine operation. No matter how much air is drawn into the oil, RPM DELO Oil is free from foam. Other compounds in RPM DELO Oil are similarly effective in preventing stuck rings and engine deposits, eliminating bearing corrosion, reducing wear.

To match the fine performance of RPM DELO OIL, use these equally efficient companion products from the same famous "RPM" line—RPM HEAVY DUTY MOTOR OIL—RPM COMPOUNDED MOTOR OIL—RPM GEAR OILS AND LUBRICANTS—RPM GREASES. For additional information or name of your distributor, write any of the companies below:

STANDARD OF CALIFORNIA • 225 Bush St., San Francisco 20, California
THE CALIFORNIA COMPANY • 17th and Stout Streets, Denver 1, Colorado
STANDARD OIL COMPANY OF TEXAS • El Paso, Texas
THE CALIFORNIA OIL COMPANY • 30 Rockefeller Plaza, New York 20

DIESEL ENGINE RPM DELO LUBRICATING OIL

by their use; different types of evaporator systems and their association with plant heat balance. 26 pages. The Griscom-Russell Co.

69 **Soot Blowers**—Bulletin F45; soot blowers in general are described. Description and operation of units, materials and specifications and other pertinent information is presented; tables of steam consumption, boiler efficiency, fuel saving chart; boiler cross-sections with blower locations indicated thereon and installation drawings and data are included; 30 pages. Marion Machine, Foundry & Supply Co.

70 **Water Heater Capacity Ratings**—14 tables are included in this ratings booklet showing capacity ratings per hour for temperature rises of from 20 deg (50 to 70 deg) up to and including ratings for a 150 F temperature rise (50 to 200 F). Table No. 15 presents the rate of flow of steam through pipes with steam from an initial gage pressure of one pound up to 150 psi. Marion Machine, Foundry and Supply Co.

71 **Fin Coils for Cooling**—Bulletin 120; directions for ordering fin coils, description of coil features, tables of dimensions, ratings, shipping weights, list prices of ceiling coils, storage coils, etc. Baffling, overhead blower units, custom built air conditioning coils and other equipment described and illustrated; 20 pages. Rempe Co.

72 **Air Ejectors**—Bulletin M-300 and M-301; what they do; types, blueprint type drawings, tables of sizes, manufacturing facilities and equipment; total 16 pages. The Lummus Co.

73 **Coal Weighing Scales**—Description; outstanding features, specifications, line drawings, photos; 4 pages. Beaumont Birch Co.

74 **Rack and Pinion Gates for Coal and Ashes**—Ball-Bearing, dust-tight features; photos, specifications, drawings, tables of dimensions; 4 pages. Beaumont Birch Co.

75 **Steam Specialties**—Collection of folders; steam trap, air trap, reducing valves, classes E. B and H pump governors, automatic boiler feedwater controller; parts and unit list prices; descriptions; illustrations; tables of capacities. The C. E. Squires Co.

76 **Deaeration**—Data book; No. N-15 gives reasons for and principles of deaeration; cold water deaeration; tabular drawing and chart material presented; well illustrated; 20 pages. Elliott Company.

77 **Power Plant, Industrial Process Equipment**—Steam turbines, turbine generators, mechanical drive turbines; motors and generators; feed-water heaters and deaerators; condensers and auxiliaries; steam jet ejectors; centrifugal blowers; turbochargers for diesels; accessories and tube cleaners; completely illustrated; 20 pages. Elliott Company.

78 **How to Choose a Steam Trap**—Trap selection, trap rating, trap capacity factors, individual trapping, determining lift; traps for unit heaters, pipe coils, fan system heating surfaces, steam jacketed kettles, autoclaves, laundry equipment, paper makers, etc.; installation, operation, maintenance, instructions; specifications and capacities; corrosive service; 42 pages. The V. D. Anderson Co.

WATER TREATMENT

79 **Index for Calcium Carbonate**—Reprint of paper by John W. Ryznar; tables and charts; 16 pages. National Aluminate Corp.

80 **Boiler Feedwater Q & A**—Bulletin 30; 102 questions and answers on various problems of boiler feedwater; 16 pages. National Aluminate Corp.

81 **Water Treatment**—Scale and corrosion control in potable water supply; reprinted paper presented by Hanlon, Steffen, Rohlich and Kessler; 12 pages. National Aluminate Corp.

82 **Water Conditioning Service**—"The 6 Fundamentals of Betz Water Conditioning Service" illustrates and describes how this company extends a supervisory service for boiler water conditioning. Booklet shows complete operation of these 6 steps; 16 pages. W. H. & L. D. Betz.

83 **Water Softeners**—Bulletin 607; benefits and economies of soft water; typical applications; how it works; types; design and features; backwash and brine rinse regulators; how to modernize present softener; aerators, degasitors, chemical feed systems, chemicals; 20 pages. Elgin Softener Corp.

84 **Softener Handbook**—Manual, semi- and full-automatic zeolite water softeners are covered in Bulletin 315. Water softener plant is discussed in the first section and operating cycles and and plant supervision is next considered. The third section is "Selecting Manual or Automatic Equipment"; this is accompanied by a table of comparison data. There also is a two-page section of tabular material and a zeolite nomographic chart. Graver Tank & Mfg. Co., Inc.

85 **Sludge Reactivator**—Illustrated booklet, 8 pages, fully explains the principle of upward sludge filtration and describes its adaptability to industrial and municipal water supplies. Charts, flow diagrams and cut-away drawings show clearly how equipment softens and clarifies raw water, materially reduces reaction time and provides, in many cases, a water that is suitable for process work without further treatment. Graver Tank & Mfg. Co., Inc.

86 **Hot Process Water Treatment**—Form 326 is a case study bulletin; covers results of an installation of the company's hot process equipment at Kankakee Ordnance Plant. System was designed to provide 60,000 gph of properly conditioned water, free from hardness, scale forming minerals and corrosive gases. Excellent photos and schematic diagram of installation with flow of water indicated. Graver Tank & Mfg Co., Inc.

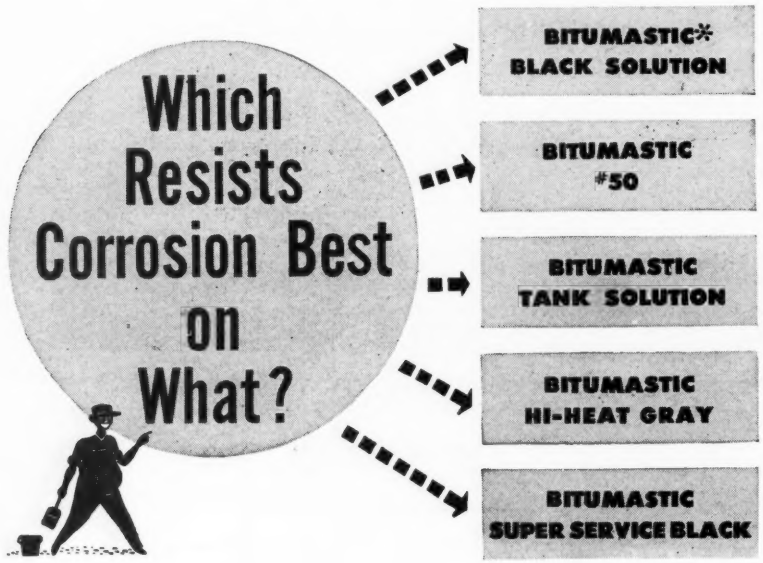
87 **Water Treatment**—Control of Fouling Organisms in Fresh and Salt Water, by John G. Dobson. Life history of these organisms; method of control. Wallace & Tiernan Co., Inc.

88 **Industrial Water Treatment**—Micro-biological Control of and Through Industrial Waters; spot summaries of improvement of process efficiency and product quality by proper sterilization. Walllace & Tiernan Co., Inc.

89 **Condenser Water Treatment**—Chlorination of Condenser Cooling Water, by R. B. Martin; important considerations in chemical treatment of cooling water circuits. Wallace & Tiernan Co., Inc.

90 **Water Treatment**—Chlorine Destroys Ammonia, by A. E. Griffin. Gives data on use of chlorine for elimination of ammonia from boiler feed water. Wallace & Tiernan Co., Inc.

91 **Clarifying and Softening Water**—Eight-page catalog "Reactivator for Clarifying and Softening Water by Upward Sludge Filtration." First part of the booklet tells how the reactivator works and how the sludge blanket is kept in control so as not to flow out with the clarified water. Line diagrams illustrate the principle of operation.



Carefully refined coal tar pitch, long proven a dependable protection against corrosion, is the base of all five. The selection of the right one for the right surface is a matter of matching product to surface and conditions.

If it's part of your job to defend metal, masonry or concrete surfaces against untimely deterioration due to atmosphere, water or chemical fumes, let us send you a folder on "Corrosion"—giving the correct use of these five surface savers. We'll also mail you regularly a bulletin devoted exclusively to the selection and application of Bitumastic protective coatings. Address Wailes Dove-Hermiston, Westfield, N. J.

*Reg. U. S. Pat. Office

GENUINE BITUMASTIC IS MADE ONLY BY WAILES DOVE-HERMISTON CORPORATION • A SUBSIDIARY OF KOPPERS COMPANY INC. WESTFIELD, NEW JERSEY

NEW YORK 4 • PHILADELPHIA 8 • CLEVELAND 14 • CHICAGO 3
HOUSTON 2 • TULSA 3 • MIAMI 36 • SAN FRANCISCO 10 • LOS ANGELES 1

"Sure we've got Wrought Iron Welding Fittings!"

WHEN you need wrought iron welding fittings *you really need 'em!* A good way of getting them is to get the Tube Turns distributor on the phone.

He handles the most complete line of welding fittings on the market, represents the one source of supply on which you can depend for all welding fitting requirements.

Tube-Turn wrought iron welding fittings are a standard part of the line as well as stainless steel, copper, aluminum, monel metal, inconel, nickel, carbon moly, chrome moly, brass. Tube-Turn welding fittings in these metals are available in all necessary weights, in a wide range of analyses, types, and sizes. The complete line of Tube-Turn welding fittings and flanges covers more than 4,000 items. Many of these are in stock with foresighted Tube Turns distributors, in every strategic industrial center, who built up a supply when this was still readily possible.

Write for the name of your nearest Tube Turns distributor and facts about how *the fittings that become part of the piping* serve others in your industry.

TUBE TURNS (Inc.) LOUISVILLE 1, KENTUCKY.
District Offices at New York, Washington, D.C., Philadelphia, Pittsburgh, Cleveland, Detroit, Chicago, Houston, San Francisco, Los Angeles.

TUBE-TURN TRADE MARK **tt** ***Welding Fittings and Flanges***

ONE SOURCE OF SUPPLY FOR ALL WELDING FITTING REQUIREMENTS

Two pages are devoted to a sectional diagram through a reactivator and the accompanying copy tells about the unit's features. Actual installations are pictured and described. Graver Tank & Mfg. Co., Inc.

92 **Feed Water Treatment**—This four-page folder tells how the company's engineering applied to boiler feed water problems can result in savings. It tells of the different procedures and presents diagrams of equipment arrangement. Typical installations in dairy, cosmetic, aircraft, laundry, and other plants are pictured. Illinois Water Treatment Co.

94 **Chemical Feeding and Proportioning**—Bulletins 1100 and 1713A; use of adjustable chemical feeder for water treating, sewage, chemical processes, petroleum; plan and sectional diagrams; descriptions; photos; general specifications; 2-page table of capacity schedules; list of chemicals handled; accessories; drawings of boiler water conditioning systems; 5-page description of method of automatic intermittent feed of conditioning chemicals direct to the boilers; 20 pages. Proportioneers, Inc.

95 **Automatic Proportioning**—Bulletin 1200, 28 pages. Handy reference book containing wealth of information on automatic flow responsive equipment and methods in continuous process operation. Photos of equipment and installations are supplemented by many flow diagrams and detail drawings. Complicated subject made exceptionally clear and understandable by careful arrangement and two-color diagrams. Proportioneers, Inc.

96 **Chemical Proportioning Equipment**—Bulletin 1714 covers chemical proportioning equipment for sea-going service. Two units—for high or low pressure—are described fully. Tabular material assists in the description. Proportioneers, Inc.

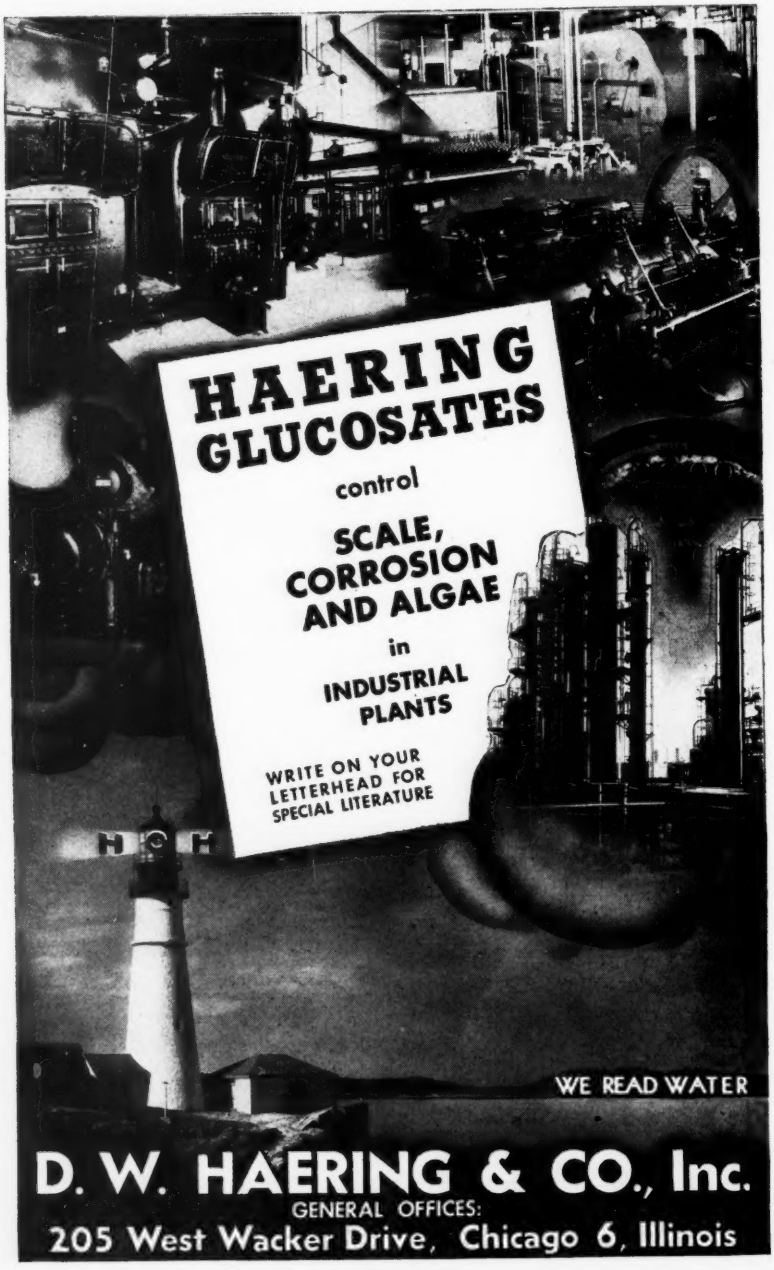
COATINGS, TREATMENT

97 **Protective Coatings**—4-page folder 844-246 describes Bitumastic Hi-Heat Gray, a specialized industrial protective coating which is said to resist corrosion and temperature up to 1200 F. The folder is in 2 colors and contains several photographs of equipment on which Bitumastic has been applied. It also gives a list of uses for the material and a chart giving its characteristics. The last page of the folder contains a brief description of four other types of Bitumastic coatings. Wailes Dove-Hermiston Corp.

98 **Fuel Oil Treatment**—A 4-page bulletin, telling about the company's treatment for fuel oil called "No Sludge." Advantages of using the treatment such as stepping up efficiency and reducing operating costs are explained. A list of dosages and applications are also given. A free test offer of the treatment is explained on the first page of the bulletin. Dominion Chemical Co., Inc.

99 **Flue Cleaner**—The company's soot and fire scale removing compound is described in this six-page folder. Results obtained from the use of this compound are described in the first part of the folder and then a list of the things which the company guarantees the material will accomplish are listed. Tables of dosage are presented and another table shows losses due to soot and fire scale. Dominion Chemical Co.

100 **Boiler Rust Treatment**—This four-page bulletin describes the company's "Rustoff" chemical which is said to "build resistance to rust and scale corroded and congested pipes." The bulletin tells haw the treatment works and what results may be expected from its use. A brief description of the campany's service department is included. Dominion Chemical Co., Inc.



HEATING, COOLING

101 **Cooling, Heating, Air Conditioning**—Collection of bulletins; installation, design, construction data, capacity ranges, condensed physical data; numerous photos of installations, full page color diagrams of flow of air, compressed air, water, water spray, etc.; 74 pages. Niagara Blower Co.

INSULATION

102 **Industrial Insulations**—Block, blanket insulations; pipe covering; new pressure coverings; insulating cement; felt; Koldboard; fill insulation; diatomaceous earth products; uses, specifications, applications, preparation; charts; photos; list prices; 26 pages. Baldwin-Hill Co.

103 **Insulating Cement**—Ease of application; efficiency; ease of maintenance; application recommendations; heat loss calculations; 4 pages. Baldwin-Hill Co.

STOKERS

104 **Air-Cooled Stoker**—Catalog R-A; features of construction; how timing device works; installation drawings, ash discharge, air cooling features; features of front end driving mechanism; engineering data tables; 20 tables. American Engineering Co.

105 **Water-Cooled Stoker**—Catalog W; drawings of installations; features; furnace views; 8 pages. American Engineering Co.

106 **Spreader Stoker**—Installation views; features of various parts; cross-sectional view of furnace with installation; listed features; 8 pages. American Engineering Co.

107 **Pneumatic Spreader Stoker**—Three-fold booklet on the inner pages of which there are 30 spirally-bound vertical pages which fold back to tell the story of the stoker, installation, features, construction, principles, engineering, types and models, typical installations; well illustrated; 33 pages. Iron Fireman Mfg. Co.

108 **Poweram Stoker**—Bulletin 7121; essentials of successful stoker; fuel control, fuel conveying, fan capacity, controls, installation; illustrations; 18 pages. Iron Fireman Mfg. Co.

109 **Coal Reference Bulletin**—Bulletin 8, Underfeed Stoker Firing. Bulletin covers factors involved in selection of multiple retort stokers, principles, design data and drawings of typical installations; 6 pages. Fairmont Coal Bureau.

OIL, GAS BURNERS

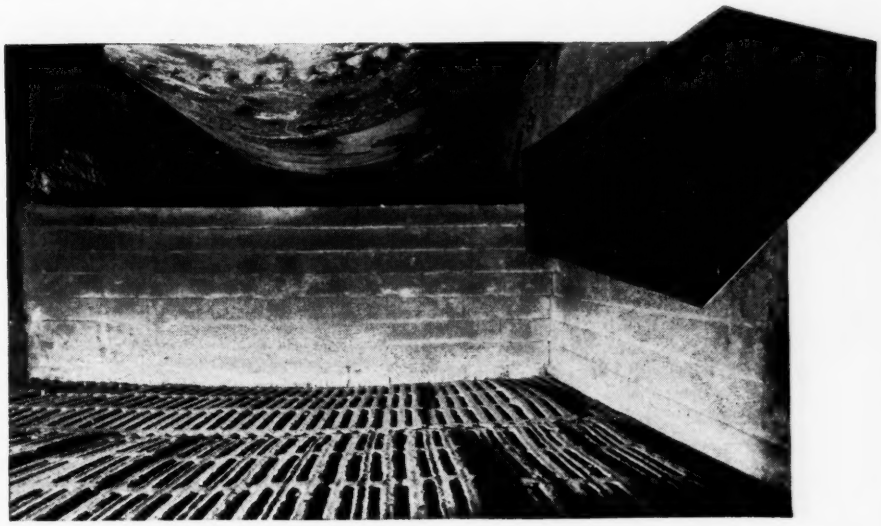
110 **Oil Burning Systems**—Bulletin 45-1; three types of systems; drawings, tables of capacities and descriptions; photos 4 pages. Faber Engineering Co.

111 **Mechanical Oil Burners**—Bulletin 45-2; two systems; drawings, tables of capacities and descriptions of units; parts list; 4 pages. Faber Engineering Co.

112 **Wide Range Oil Burning System**—Bulletin 109; How the system operates; control; drawings; 4 pages. Peabody Engineering Corp.

113 **Oil Burners**—Bulletin 108; Two types of oil burners, A and H; air registers, oil atomizers, drawings; 4 pages. Peabody Engineering Corp.

For Longer Life in Boiler Furnaces Use Norton Company's CRYSTOLON BRICK



For longer life in boiler furnaces power engineers specify Norton Company's CRYSTOLON Brick because of these qualities: (1) high refractoriness, (2) chemical stability, (3) great strength at elevated temperatures, (4) remarkable resistance to abrasion, (5) greater resistance to spalling than any other refractory material, (6) strong resistance to both the chemical and physical action of molten slag. For proof we offer the above illustration showing CRYSTOLON Brick still in excellent condition after 12 years of trouble-free service in a school boiler.

NORTON COMPANY - Worcester 6, Mass.

CRYSTOLON—Trade-mark Reg. U. S. Pat. Off.

There is a LUBRIPLATE Dealer near you . . . at the other end of your local telephone. He stands ready to prescribe the LUBRIPLATE Lubricant that will make your machinery last longer, run smoother and produce more product at less cost. He has a complete stock on hand to give you prompt delivery. Give him a ring.

LUBRIPLATE

Lubricants definitely reduce friction and wear to a minimum. They lower power costs and prolong the life of equipment to an infinitely greater degree. LUBRIPLATE arrests progressive wear.

LUBRIPLATE

Lubricants protect machine parts against the destructive action of rust and corrosion. This feature alone puts LUBRIPLATE far out in front of conventional lubricants.

LUBRIPLATE

Lubricants are extremely economical for reason that they possess very long life and "stay-put" properties. A little LUBRIPLATE goes a long way.

LUBRIPLATE

FISKE BROTHERS REFINING CO.

NEWARK 5, N. J. TOLEDO 3, OHIO

DEALERS FROM COAST TO COAST

CONSULT YOUR CLASSIFIED TELEPHONE BOOK

114 **Gas Burners**—Bulletin 203; description of A and H gas burners; cross-sectional diagram; photos of atomizers; 4 pages. Peabody Engineering Corp.

OIL, LUBRICATION

115 **Lubrication Recommendations** — Special oils for diesels and heavy-duty gasoline engines; facts about oil; tables of recommended oils for various models; 18 pages. Standard Oil Company of California.

116 **Cutting Fluids**—Facts about cutting fluids; machine tool operations; fundamentals of cutting; how to apply; metallic cutting tools; tabular material; show practices; 50 pages. Standard Oil Company of California.

117 **Diesel Operation**—Relation of fuels and lubricants to the operating efficiency in the diesel engine; diesel fundamentals; maintenance; lubrication and fuels; supercharging; selection and classification of fuels; fuel injection maintenance; improving cleanliness; tabular material, charts, formulas; 114 pages. The Texas Co.

118 **Engineers Report on Oil**—Engine tests, laboratory tests, effects on engines, bearing corrosion, actual service data, filter clogging, service experience; well illustrated with photos and charts; 42 pages. Standard Oil Company of California.

119 **Lubricants Service Handbook**—28 pages in this booklet on lubricants and their application. The development of the lubricant, its features and advantages and the manner in which it meets various operating conditions take up the fore part of the booklet. Two pages are used to cover definition of the various types of lubricants in the line, both fluid and grease type. "Application of Lubriplate Lubricants" is a useful section of the book; it shows and tells by sketch and description where the various lubricants should be used and why. The most useful part of the book is the "Recommendations" section where the manufacturer tells just what grease or oil should be used according to speeds, temperatures, pressures and general service conditions. Fiske Brothers Refining Co.

POWER TRANSMISSION

120 **Speed Reduction, Increase Gear**—Bulletin S-130; description; gear cases; gear and pinion; bearings; lubrication; drawings and photos; 8 pages. The Terry Steam Turbine Co.

121 **V-Belt Drive Guide**—Bulletin B6051F; guide to company's complete line of V-belt drives. Contents include types and sizes. V-belt prices, how to figure drives, belt selector charts and tables and similar engineering information. Well illustrated; 12 pages. Allis-Chalmers Mfg. Co.

122 **Chains and Sprockets**—Bulletin D-1; 2 color digest catalog, profusely illustrated, gives pertinent information on drive and conveying chains and sprockets, finished steel roller chains and sprockets, silent chains and sprockets, flexible couplings. Tables of numbers and pitches are given as are full page tables of list prices, dimensions and weights; 16 pages. Union Chain & Mfg. Co.

123 **Flexible Couplings**—Bulletin 57; 2 pages of drawings and tables of ratings for company's flexible couplings. Installations are shown and features of the various types are discussed; 20 pages. John Waldron Corp.

VALVES

124 **Regulating Valves**—Bulletin 1-A; valve data book; description, dimensions and lists of parts; typical installations; rated capacities; prices; 52 pages. Atlas Valve Co.

125 **Pressure Regulator**—Bulletin 1-B; description, installation, operation; list prices; sectional and installation views; parts lists; 8 pages. Atlas Valve Co.

126 **Pressure Reducing Valves**—Bulletin 1-C; sectional drawings, list prices, dimensions and weights; operation and adjustment; capacities for steam and air; 12 pages. Atlas Valve Co.

127 **Corrosion Resistant Valves**—Two bulletins, both of them on corrosion resistant valves have just been issued. One of them, a technical information bulletin covers the mechanical properties, analysis range, applications, advantages and sizes and specifications of the valves. The other is devoted to a photographic display of the installation of the valves. Alloy Steel Products Co.

128 **Pressure Reducing Valves**—Bulletin 401-A; selection of proper valve; construction; installation; capacity tables; interchangeability; dimension tables. 14 pages. Leslie Co.

129 **General Service Valves**—Bulletin E-150; valves for blow-off; fire protection, soot blower lines, acids, process, etc.; descriptions; exploded views; features; dimensions, weights and

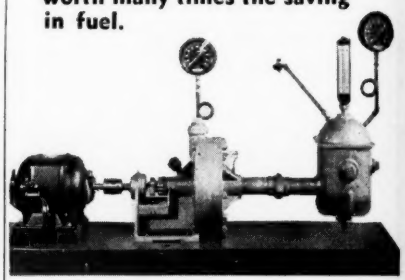
MORE PRODUCTION WITH LESS FUEL

That is the Unanimous Verdict of our Many Customers Using Process Steam.

Our Direct Return System collects condensate—ALL OF IT—at high pressure and temperature, and returns it to the boiler without traps. This saves fuel, usually 25% or more. Also saves water and water treatment materials—and the usual flash steam loss is eliminated.

Keeping jackets, coils, steam lines and drain lines free from water (no waiting for traps to fill up and dump) means that dry hot steam is available everywhere all the time.

You are thus assured hotter steam heated units, quicker heating up of cold units and a reduction in cooking or drying time (frequently 15% or more) and a corresponding INCREASE IN PRODUCTION, worth many times the saving in fuel.

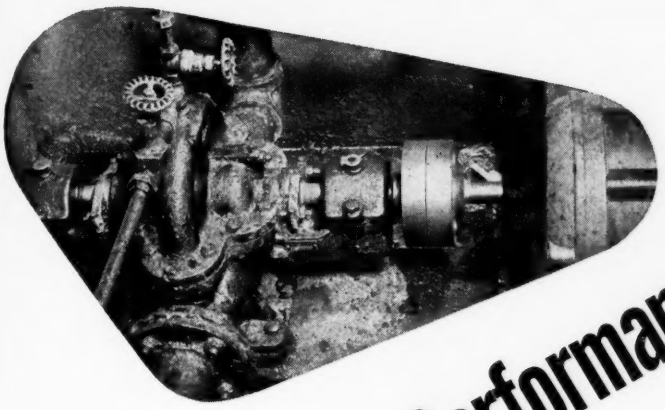


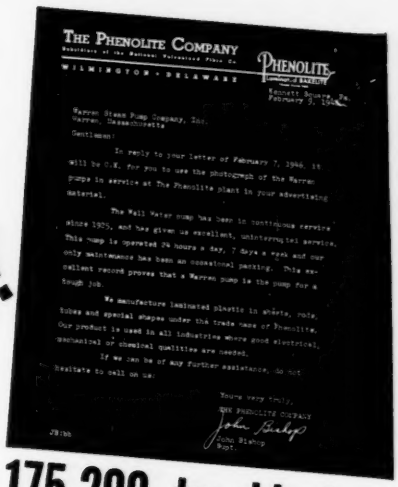
This simple outfit is entirely self-contained. It comes all aligned and mounted on a metal base ready to be bolted down to a level foundation and started in operation. Capacity 10,000 lb. of condensate per hour under 20 lb. dynamic head. Other units up to 50,000 lb. of condensate per hour and up to 80 lb. dynamic head.

Write for descriptive bulletin and testimonials from many satisfied customers.

HEAT RECLAIMER CORPORATION

Engineers and Manufacturers
6 North Michigan Avenue
Chicago 2, Ill.





THE PHENOLITE COMPANY

PHENOLITE

WILMINGTON • DELAWARE

Kennett Square, Pa.
February 7, 1946

Warren Steam Pump Company, Inc.
Warren, Massachusetts

Gentlemen:

In reply to your letter of February 7, 1946, it will be O.K. for you to use the photograph of the Warren pumps in service at The Phenolite plant in your advertising material.

The Wall Water pump has been in continuous service since 1925, and has given us excellent, uninterrupted service. This pump is operated 24 hours a day, 7 days a week and our only maintenance has been an occasional packing. This excellent record proves that a Warren pump is the pump for a tough job.

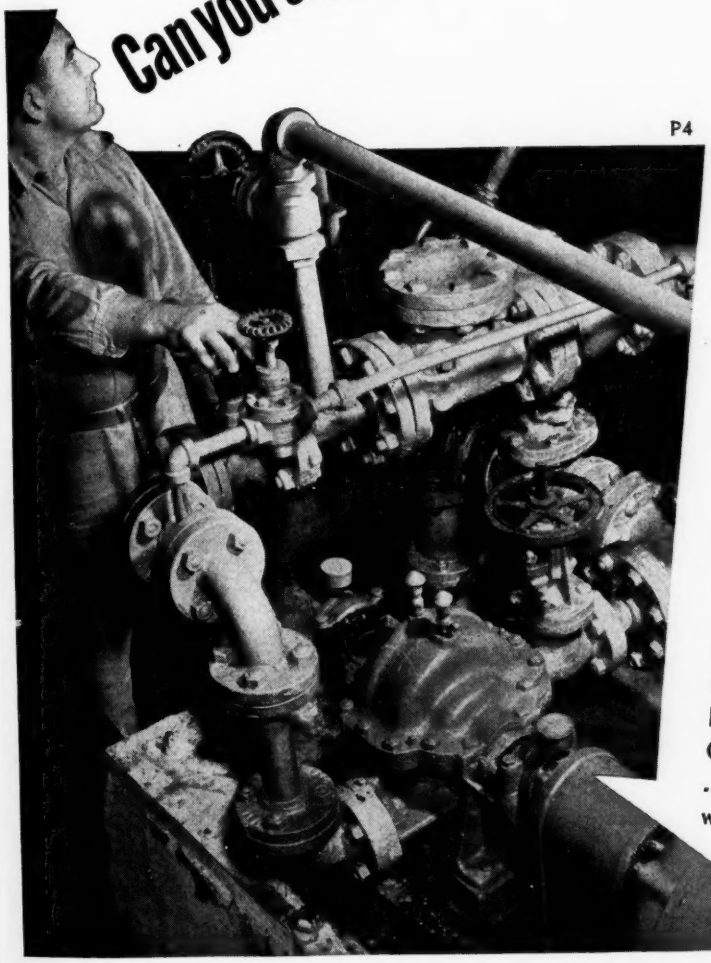
We manufacture laminated plastic in sheets, rods, tubes and special shapes under the trade name of Phenolite. Our product is used in all industries where good electrical, mechanical or chemical qualities are needed.

If we can be of any further assistance, do not hesitate to call on us.

Yours very truly,
THE PHENOLITE COMPANY
John Bishop
Supt.

JB:bb

Can you top this Performance?



P4

175,200 trouble-free pumping hours

This is the record set up by a Warren Single Stage, Double Suction, Centrifugal Pump at the plant of The Phenolite Company, Kennett Square, Pa. This is based upon twenty years of continuous 24-hours-a-day, 7-days-a-week service. The pump, of necessity, is located in a pit 10 feet in depth, with six inches of water in the bottom and plenty of moisture on the side-walls. A tough job, requiring a tough pump . . . and yet over this long period the user says the only maintenance has been an occasional packing! Other Warren Pumps at Phenolite, and elsewhere, are performing equally well.

If your pumping problem involves General Water Service, Boiler Feed, Paper Mill Services, Process, Dewatering, Condensate Return, Oil Handling, Hydraulic Pressures . . . or other services, your inquiry will receive prompt attention.

For greater dependability, longer life, lower maintenance

WARREN STEAM PUMP COMPANY, INC.
WARREN, MASS.

Atlanta Boston Chicago Cleveland Detroit Houston Hartford
Indianapolis Los Angeles Minneapolis New Orleans New York
Philadelphia Pittsburgh Richmond San Francisco Seattle

WARREN PUMPS

LEARN THE SECRET OF BIG EARNINGS IN

COMBUSTION ENGINEERING

There are plenty of big jobs today in Combustion Engineering. Such jobs have always been big pay jobs —and today they are better than ever. High fuel and equipment costs means a greater demand for combustion trained men than ever before.

Do you want such a job? You can have it—if you will train for it. And that is *easy to do.* Just a little of your spare time is required for the simple, easy-reading, practical Hays Home Study Course in Fuel and Combustion engineering.

A few of our friends whose employees have advanced through Hays training:

- International Harvester Co.
- Armour & Co.
- Combustion Engineering Co.
- Riley Stoker Corp.
- Iron Fireman Mfg. Co.
- Commonwealth Edison Co.
- State of Illinois Cities Service (Oil & Power)

and many others.

For 28 years we have specialized exclusively in such training. Today, Hays trained men are more in demand than ever. Now is the time to do what hundreds of others have done who hold substantial positions of responsibility today.

Write for Free Book Now!
Don't Delay! Mail Coupon Today!

You can't lose by getting the facts. We'll send our book, "Opportunities for the Combustion Expert" without obligation or expense to you. Learn how every lesson is administered by trained practical staff men who give the utmost in help and guidance. Get complete outline of course. Learn how to become a key man in Combustion. Send in the coupon now!

Hays Institute of Combustion
430 N. Michigan Ave., Chicago 11, Ill. (Dept. 22)
Our 28th Consecutive Year

HAYS INSTITUTE OF COMBUSTION
430 N. Michigan Ave., Chicago 11, Ill.
Dept. 22

Please send me your Free Book "Opportunities for the Combustion Expert"—No obligation.

Name.....
Address.....
City..... State.....
Company Name.....

DEPARTMENT OF TECHNOLOGY
BUSINESS & PUBLIC LIBRARY

list price tables; parts and parts list; 14 pages. Everlasting Valve Co.

130 **Valves**—Bulletin E-100; for boiler room service; photos, descriptions, parts; features; pressure rating indexes; size shipping weight and price tables; ordering information; 30 pages. Everlasting Valve Co.

131 **Multiport Relief Valve**—Bulletin 4150; complete description of valves and operating characteristics, photographs of typical installations. Engineering data includes sizing information tables, nomenclature, installation and operation, list prices of accessories, dimensioned drawings and tables of dimensions; 28 pages. Cochrane Corp.

132 **Steel Valves**—Bulletin 102; 4 page bulletin describing company's "Evrtyte" valves. Cross-sectional illustrations and tables of seat orifice sizes, prices and dimensions are given; listing of features, description of the operation of the unit and parts and prices for assemblies. Strong, Carlisle & Hammond Co.

MAINTENANCE

133 **71 Maintenance Jobs**—This guide tells how better to perform commonly occurring power plant maintenance and cleaning operations. Illustrated manual gives specific material and method recommendations for handling cleaning, degreasing, descaling, derusting, paint stripping, etc. Booklet is completely indexed and reference is made easy by colored type strips on edge of the pages; 22 pages. Oakite Products, Inc.

134 **Maintenance, Repair Tools**—Company's line of pneumatic drills, screw drivers, file and die grinders, riveting hammer and pneumatic tool accessories. Other tools include metal etchers, chucks, portable demagnetizers and many others. Completely illustrated; 24 pages. Ideal Industries, Inc.

135 **Protecting Metal**—High heat resistant coatings for protecting metal surfaces in power and processing equipment are covered in 4 page bulletin. Brief description of properties of coatings are given. The Dampney Co. of America.

136 **Condenser Tube Inserts**—Description of Flowrites; illustrated, accompanied by report of tests on Flowrites made by M.I.T. Tables and charts of test results are presented; description of how to install inserts given; 8 pages. Condenser Service & Engineering Co., Inc.

CONTROLS, METERS

137 **Pressure Controllers**—Bulletin 402; air, gas, steam or water service; when to use; selecting diaphragm regulating valve; sizing and capacity; operation; installation; ordering; specifying; dimensions; diaphragm regulating valves; 12 pages. Leslie Co.

138 **Pump Governors**—Bulletin 403-A; reciprocating, turbine-driven, motor-driven pumps; selection of governor; construction; pressure, capacity tables; insulation; sizing; specifying; dimensions; 12 pages. Leslie Co.

139 **Temperature Regulators**—Bulletin 404-A; heating or cooling service; selection of regulator; temperature and pressure ranges; installation; various types described and pictured; ordering and specifying; complete tabular material; 16 pages. Leslie Co.

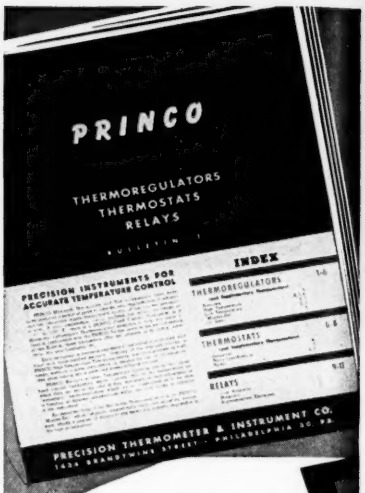
140 **Damper Regulators**—Bulletin 4-A; for low pressure heating, medium pressure power and high pressure power boilers; what they do; how to specify; typical installations (drawings); adjustments; list prices; technical descriptions and parts lists; 20 pages. Atlas Valve Co.

141 **Thermostats and Relays**—Bulletin T, a 12-pg. catalog presents significant information on this company's mercurial thermostats and adjustable thermoregulators. Also included is complete data on relays, designed as companion instruments to the above mentioned. Complete descriptions of the instruments are included and the bulletin is well illustrated. Precision Thermometer & Instrument Co.

142 **Recording Flow Meter**—Bulletin 349; what it does, features, chart of rated capacity; construction and operation; installation drawings, tables of capacity; photos; 8 pages. Builders-Providence, Inc.

143 **Propeller-Type Meter**—Bulletin 350A; for main-line metering; applications, description, installation, materials of construction; features; table of capacity, shipping weights; specifications, drawings; 4 pages. Builders-Providence, Inc.

144 **Centralized Combustion Control**—Bulletin 43-605; applications to various types of fuels and burning equipment; controller, measuring elements, pilot device, power unit, etc.; 24 pages. The Hays Corp.



for INFORMATION on PRECISE TEMPERATURE CONTROL

—Send for this *PRINCO* BULLETIN

Bulletin "T" has complete details on PRINCO Temperature Control Instruments, including Models for *EXTRA* HIGH PRECISION, HIGH TEMPERATURES, LOW TEMPERATURES, SEVERE SERVICE, etc., for use in *industrial, laboratory, marine,* and many other applications. Write for your copy of this Bulletin for your files — TODAY.

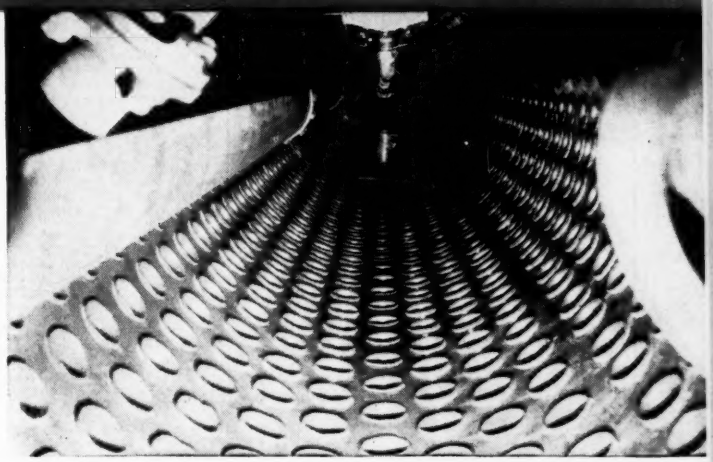
PRECISION
THERMOMETER & INSTRUMENT COMPANY
PRINCO
PRECISION INSTRUMENTS FOR INDUSTRY
1402 Brandywine Street, Philadelphia 30, Pa.

DOWELL

SUBSIDIARY OF THE DOW CHEMICAL COMPANY

full power restored

with Dowell chemical cleaning



Leading engineers, responsible for power plant efficiency, have found in Dowell's *chemical* cleaning service a modern method for *reducing costs*. They know that more efficient operation of boilers, condensers and other heat-exchange equipment is achieved easily after chemical scale removal service. Power plant operators can see for themselves how safe, how rapid, how effective this tested process really is—when applied by *specialists* in chemical cleaning.

Dowell engineers fill the equipment with liquid solvents designed to dissolve and disintegrate the accumulated scale and sludge. They are experienced in practical methods, know which solvents to use, and bring with them adequate equipment—special truck-mounted tanks, pumps, mixers, heaters—for complete control of each stage in the successful job. To save dismantling and down time—to reduce operating costs—call Dowell. Ask for "More Power to America's Industry!"—free color booklet showing how Dowell service engineers use chemicals to clean steam generating equipment, heat-exchangers, water wells, cooling jackets and many other types of equipment.

FREE SHOWING! *New 18-minute sound slide film illustrating the possibilities of Dowell Chemical Scale Removal Service. To arrange a special showing call or write Dowell.*

DOWELL INCORPORATED • TULSA 3, OKLAHOMA

New York, Philadelphia, Boston, Baltimore, Pittsburgh, Buffalo, Cleveland, Cincinnati, Detroit, Chicago, St. Louis, Kansas City, Wichita, Oklahoma City, Houston, Fort Worth, Shreveport, Mt. Pleasant, Michigan; Salem, Ill.; Borger, Texas; Wichita Falls, Texas; Midland, Texas; Lafayette, La. Long Beach, Casper: Dowell Associate—International Cementers, Inc.

Dowell's industrial engineers are thoroughly experienced in successful chemical cleaning. They are supported by the full research and technical resources of Dowell's own laboratories.

Dowell's field equipment includes the most modern types of scientific devices. Solvents for Dowell chemical scale removal service are mixed especially to fit each individual job.

DOWELL

FOR INDUSTRIAL CHEMICAL SERVICE

Clean Without Dismantling FUEL OIL HEATERS

PROBLEM: Excessive accumulation of gummy deposits inside fuel oil pre-heaters tubes. Heat transfer seriously curtailed. Fuel oil circulated at temperatures too low to insure the proper viscosity at normal pump pressure. Thorough cleaning needed.

SOLUTION: Introduce recommended Oakite cleaning material. Let soak or circulate as directed; drain. All accumulations quickly, thoroughly removed. Full heat transfer restored. No dismantling, wire brushing or removal of tube nests required. Cleaning cost is low.

FURTHER DETAILS:
For the inside story about this Oakite cleaning technique together with helpful hook-up diagram write on letterhead for 20-page Power Plant Digest. Or, if you'd like on-the-spot help with your cleaning problems, ask your nearby Oakite Technical Service Representative to stop by. No obligation either way.

OAKITE PRODUCTS, INC., 116 Thames St., NEW YORK 6, N. Y.
Technical Representatives in Principal Cities of U. S. & Canada

OAKITE
REG. U. S. PAT. OFF.

Specialized Industrial Cleaning
MATERIALS • METHODS • SERVICE

145 **Combustion Meters**—Bulletin 44-550; reasons why it is; accurate, dependable, simple, rugged, easy to install, easy to maintain, speedy, easy to understand; well illustrated by explanatory diagrams; 16 pages. The Hays Corp.

146 **Feedwater Textbook**—"Mechanical Feedwater Regulation for Boilers" by Prof. E. P. Culver; principles of feedwater regulation; mechanical equipment available; differential pressure control; feed pump control; illustrations, diagrams, charts; 36 pages. Northern Equipment Co.

147 **Engineering Monographs**—Series of eight on automatic combustion control; 1. How Close Can Steam Pressure Be Controlled? 2. Why Operate Automatic Combustion Control from Changes in Steam Pressure? 3. Adapting to the Characteristics of Underfed Stokers. 4. Adapting to Spreader Type Stokers. 5. Adapting to Chain or Traveling Grate Stokers. 6. Adapting to the Characteristics of Pulverizers. 7. Adapting to the Characteristics of Oil Burners. 8. Adapting to the Characteristics of Gas Burners; total 37 pages. The Hays Corp.

148 **Draft Gages**—Bulletin 46-667; gages for indicating, recording of drafts, pressures, differentials, temperatures; pressure-draft tables; descriptions of equipment; differential units, Bourdon tube units, pointer gages, etc.; 20 pages. The Hays Corp.

149 **Draft**—Bulletin 46-472; what draft is; where it is found; how it is measured; what the draft gage tells; where to measure draft and pressure in steam plant; where to connect draft gages; how to install; drawings; 20 pages. The Hays Corp.

150 **Flue Gas Analyzer**—Bulletin 45-668; principle of operation; construction features; technique; models and prices; Burrettes—classifications and uses (table); what flue gas analysis tells us; 16 pages. The Hays Corp.

151 **Indicating, Control Systems**—What they are, what they can do; Bulletin 14B6641. Description of how transmitter, receiver and indicator of systems are constructed, how they work, their advantages and specifications. Illustrated with photographs, diagrams, charts; 12 pages. Allis-Chalmers Mfg. Co.

152 **Water Gages**—Condensed catalog, Bulletin E, of company's complete line of water gages. Each model illustrated and accompanying table gives sizing information; 8 pages. Ernst Water Column & Gage Co.

153 **Pyrometer Buyers' Guide**—Bulletin 100-1; illustrated table of contents, directions for selecting proper thermocouples, charts and diagrams. Detailed information includes complete description of material for assembled thermocouples and components; prices are listed; 40 pages. Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co.

154 **Stainless Steel Bellows**—Bulletin SSB-46; contains diagrammatic cross-section views and up-to-date information concerning the use of these bellows as equalizers, compensators, expansion joints, flexible connectors, for flow control, vapor and steam traps, thermostatic instruments, etc. Completely illustrated; 12 pages. Chicago Metal Hose Corp.

155 **Pitot Equipment**—Three section Bulletin 50; gives complete details of the use of Pitot tubes and rods, instructions in the use of the company's portable Pitot recorder, together with theory, formulae, notations and curves. Completely indexed; 20 pages. Simplex Valve & Meter Co.

156 **Manometers**—Bulletin 200; describes completely this line of fixed and portable manometers for use in water surveys and similar flow rate measurement, valuable engineering data also included. Illustrations include line drawings and photographs; 8 pages. Simplex Valve & Meter Co.

157 **Instruments, Controls for Process**—Bulletin 17; process controllers, control components, measuring components and instrument combinations briefly described and illustrated. Application data such as sizes, pressure standards and ranges are listed; 8 pages. Bailey Meter Co.

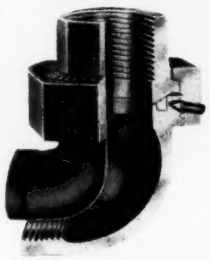
158 **Temperature Regulators**—Bulletin 7-A; six types; descriptions, list prices, tabular material, photos; list of parts; typical installation drawings; tables for finding sizes of control valves required to heat given quantity of water; 16 pages. Atlas Valve Co.

159 **Draft, Excess Air and CO_2**—Bulletin 39-341; discussion of the relation of these elements to the installation and servicing of bituminous and anthracite stokers by Arnold Soller; 12 pages. The Hays Corp.

PACKING, GASKETS

160 **Packings**—Bulletins P3, P14, P25 and P22; descriptions, tables of size and size number; tables of service for various packings, prices; 18 pages total. Greene, Tweed & Co.

Simplify YOUR PIPING MAINTENANCE with JEFFERSON UNIONS

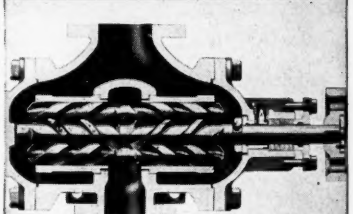


with the RECESSED BRASS SEAT

The *brass-seating feature* of all Jefferson Specialty Unions means important savings in piping maintenance because there are fewer joints involved at points where unions are used; also guards against shutdowns because it gives leak-proof tightness without undue pressure.
The 90 deg. Union Elbow shown is representative of the complete line of Jefferson Specialty Unions to meet all piping applications. Write for descriptive catalog or get in touch with your nearest distributor.

JEFFERSON UNION CO.
601 West 26th St., New York 1, N.Y.
Factories at Lexington 73, Mass., and Lockport, N. Y.

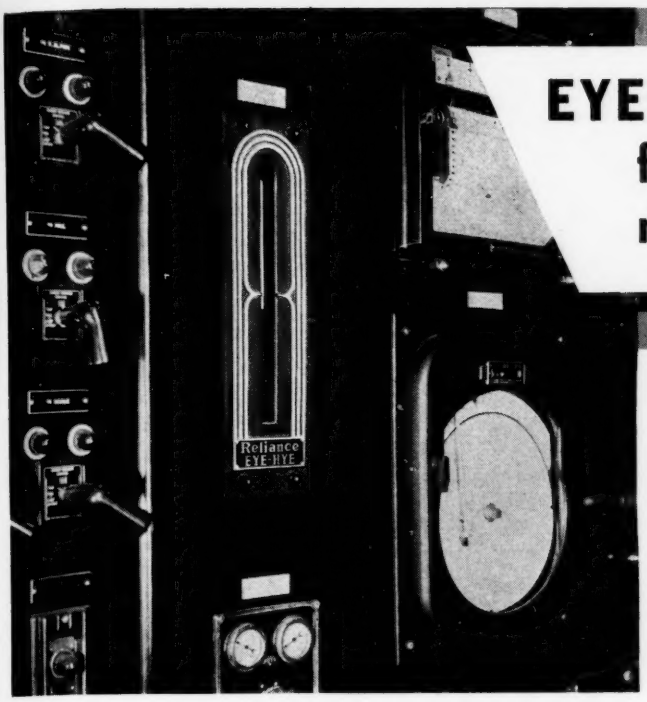
TO KEEP NOISE *OUT* – PUT IMO *IN*



Where quiet, vibration-free pumping is essential, use an IMO . . .
made for handling oils and other liquids at all capacities and pressures
1-127

For further information write for Catalog-127-G

IMO means I MOVE OIL
IMO PUMP DIVISION of the
DE LAVAL STEAM TURBINE CO.
TRENTON 2, NEW JERSEY



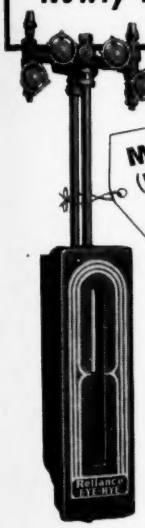
EYE-HYE brings you accurate fool-proof remote water-level reading for any boiler or tank

The eye-level gage that covers the "water-level front"

This is a "doctored" photograph of an existing EYE-HYE installation, to show you how new Model E-31 will soon appear on instrument panels. None have been installed at the time of preparation of this advertisement.

On the panel board, EYE-HYE takes its place with instruments. The face plate mounts on the front, protruding only three-quarters of an inch. Tubes may be offset to clear instrument mechanisms in the rear.

Another EYE-HYE Model *Newly Styled— Newly Engineered*



MODEL E-30
(E-31 for panels)
for pressure to 900 lbs.

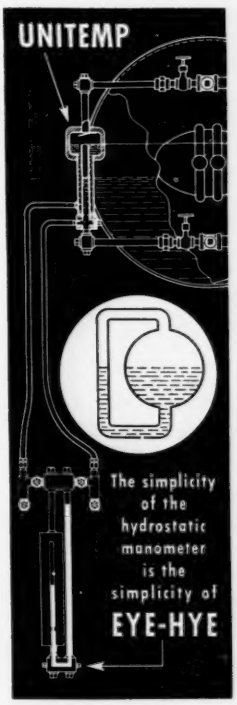
EYE-HYE may be mounted on a wall or pillar, or on a specially constructed stand or panel if not placed on the main instrument board. It is usually hung with its window about 5 feet from the floor.

● EYE-HYE assures you *perfect measurement, dependability* and *clear reading* (in familiar water gage style) in your remote reading water level indication. It saves your engineers thousands of steps, hours of valuable time; gives them safe, convenient gage reading *down at eye level* or away from obstructions and hidden corners, for main boilers, auxiliary boilers, heater tanks, storage tanks and similar vessels. It places water level supervision on a plane with other power plant control facilities.

EYE-HYE's manometer-like simplicity (see diagram) is easy to understand. Positive hydrostatic operation, with no mechanical parts to wear, adjust or get out of order inspires the complete confidence of operators. Calibration is fixed—cannot be tampered with in service. Time after time, EYE-HYE has proved more dependable than the boiler gage.

Added to redesigned models recently announced, Model E-30 and E-31 are pictured here for the first time—provide for pressures to 900 lbs. The same outward appearance will identify models for pressures to 2000 lbs. There's no change in the EYE-HYE basic principle; redesigning is for new appearance and improved construction.

Investigate *now* the possibilities of increasing the efficiency and safety of your water level supervision with the Reliance EYE-HYE.



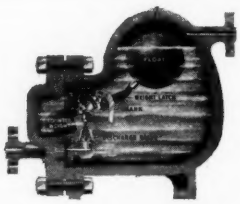
BOILER SAFETY DEVICES since 1884

Reliance

THE RELIANCE GAUGE COLUMN CO. · 5902 CARNEGIE AVENUE · CLEVELAND 3, OHIO

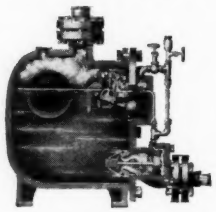
7 Reasons Why Nicholson Traps

REQUIRE



MINIMUM MAINTENANCE

1) Leak-proofed by positive fluid seal over valve.
2) Not dependent on buoyancy or weight of float.
3) Unaffected by re-evaporation of condensate.
4) Non-wire drawing.
5) Rugged, to withstand unavoidable abuse.
6) Not easily affected by dirt, pulsation, etc.
7) Of stainless steel where it counts.

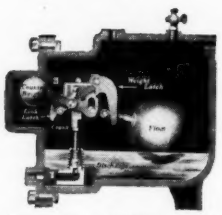


A TRAP FOR EVERY PURPOSE

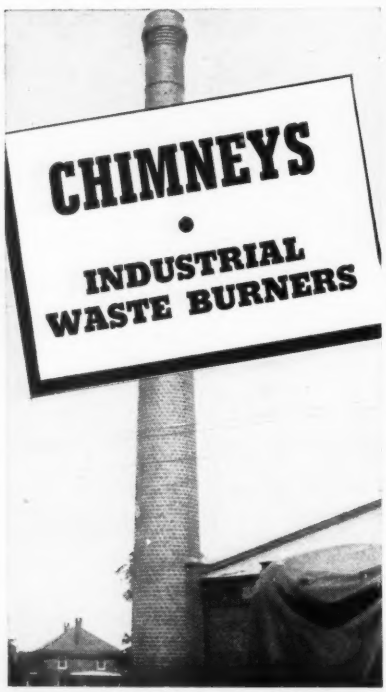
In addition to a complete line of weight and piston-operated traps for steam, air and gasoline, Nicholson also furnishes: expansion traps for steam pressures to 225 lbs.; industrial thermostatic traps for pressures to 225 lbs.; and thermostatic radiator traps for pressures to 25 lbs. Let us send you . . .

CATALOG 444 or SEE SWEET'S

W. H. NICHOLSON & CO.
160 OREGON ST., WILKES-BARRE, PA.



Top and bottom traps shown are weight-operated; middle, piston-operated. Pressures to 1500 lbs.



AMERICAN CHIMNEY CORP.
143 Fourth Ave., New York 3, N. Y.
BRANCHES:
BOSTON • PHILADELPHIA • CLEVELAND
DETROIT • PITTSBURGH • CHARLOTTE

GOLDEN-ANDERSON
design and build
over 1500
types and sizes in

automatic
VALVES
for safe protection on any high pressure installation

In addition to more than 1500 standard types and sizes of manual or automatic steam and water service valves—GOLDEN-ANDERSON engineers design and build special valves to meet most any difficult high or low pressure service.

Write today for descriptive, technical catalog.

GA
GOLDEN-ANDERSON
VALVE Specialty Company
PITTSBURGH 22, PA.

161 **Packing**—Bulletin 237; photos and descriptions of use; installation drawings; standard size table; 4 pages. Warren Steam Pump Co., Inc.

FITTINGS

162 **Standards for Flanged Fittings, Valves, Flanges**—Pressure-temperature ratings, tables and charts, rating procedure, flange materials, safety factors, loading, stress formulas; 20 pages. Tube Turns, Inc.

163 **Welding Fittings**—Allowable working pressures; power, oil, district heating, refrigeration, gas and air piping; 14 tables and directions for use; 18 pages. Tube Turns, Inc.

164 **Welding Fittings**—Volumetric capacities; 2 pages of formulas for computation of capacities; 6 pages of tables; 12 pages in book. Tube Turns, Inc.

165 **Reference Tables and Data**—Bulletin 406; properties of saturated steam; velocities for fluid flow through pipe; saturated steam capacity of pipe; dimensions of extra-strong pipe; areas or circles and gal per ft of cylindrical length; engineering computations; 4 pages. Leslie Co.

166 **Unions**—Complete line of malleable iron unions and convenience unions; illustrations, descriptions, size and list prices; descriptions of materials and workmanship; 24 pages. Jefferson Union Co.

PUMPS

167 **Horizontal Duplex Piston Pumps**—Bulletin 230-1; specifications, steam end, liquid end; capacity tables for pressure service, light pressure service; dimensions, drawings, tables; 4 pages. Warren Steam Pump Co., Inc.

168 **Steam Heat Vacuum Pumps**—Bulletin 226-1; specifications, drawings, general information, tables of sizes and capacities; 4 pages. Warren Steam Pump Co., Inc.

169 **Centrifugal Pumps**—Bulletin 302-30, Revised; instructions for installation and operation; drawings, tabular material; 12 pages. Warren Steam Pump Co., Inc.

170 **Hydraulic Pressure Pumps**—Bulletin 238; specifications, sectional photos, important features; full page table of capacity, sizes, pipe sizes, pressure; 4 pages. Warren Steam Pump Co., Inc.

171 **Screw Pumps**—Recommended uses; advantages; tables of capacities and sizes; charts of test results; dimensioned drawings; suctions and discharge, packing box sizes, shipping weights tables; specifications; installation and maintenance; theoretical horsepowers; viscosity classifications; 18 pages. Sier-Bath Gear & Pump Co., Inc.

172 **Centrifugal Pumps**—Booklet describes basic action of centrifugal pumps, tells of the science of centrifugal action and the physics of pumping. Performance curves are presented. Descriptions of the company's self-priming centrifugal pumps are given and how they operate is explained. Typical uses of the units are pointed out and installation and operation explained; 20 pages. Marlow Pumps.

MISCELLANEOUS

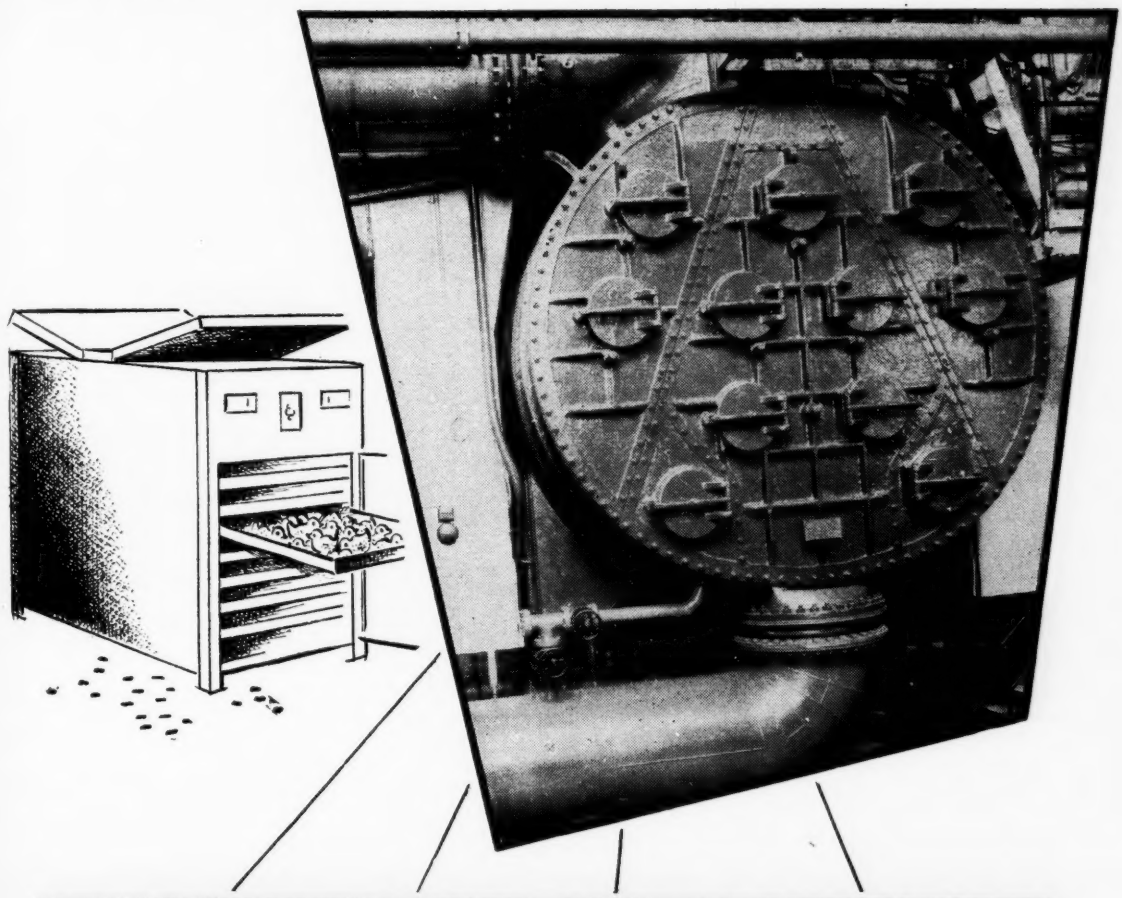
173 **Whistles and Signals**—Bulletin 421; for industrial, marine, railroad service; selection; construction; advantages; operation; ordering and specifying; 8 pages. Leslie Co.

174 **Electric Tools**—Bulletin 464; covers complete line of portable electric tools for construction and briefly describes such tools as electric hammers, drills, chisels, vibrating tools, accessories, screw drivers, etc. Prices are given. Syntron Co.

175 **Refractory Concrete**—"Lumnite for Refractory Concrete"; basic information on materials and methods used in making refractory concrete. Illustrations show application of concrete in construction of furnaces, coke ovens, etc. Another section covers concrete use in foundations, floors and structures subject to high heat; 24 pages. The Atlas Lumnite Cement Co.

176 **Gas Purger for Refrigeration System**—Bulletin 160; tells how to cut power costs and raise condenser capacity by proper purging of non-condensible gases. Tables of ammonia properties, advantages and complete illustrated material. Typical installations are pictured. Two pages with diagrams tell how purger operates; 8 pages. Armstrong Machine Works.

177 **Grinding Wheels**—Grinding wheels of various abrasives are illustrated and list prices presented; tables of sizes in inches are accompanied by photographs and line drawings of these various wheels. Grinding wheel dressers with list prices are shown; 32 pages. Norton Co.



Incubator for Micro-Organisms

Condensers and other heat exchange equipment form a vital part of your plant. They were designed and installed for specific purposes – yet with unchlorinated cooling water they can quickly become costly incubators for slime-forming micro-organisms.

Most cooling waters are polluted by bacterial contamination that thrives on warm, water-side surfaces. These slimes reduce heat transfer and increase fuel and cooling water costs. Their removal by plug cleaning means added labor expense and reduced plant capacity while the equipment is out of service.

To avoid these operating difficulties and unnecessary costs, more and more plants are adapting chlorination by the W & T De-Sliming Process. And W & T Engineers with over 30 years experience in water treatment will gladly give you information on the equipment best suited to your particular plant.

Whether you use fresh or salt water – open or closed system – chlorination can eliminate slime losses and increase condenser efficiency, so write for details today.

WALLACE & TIERNAN
PRODUCTS, INC.

Manufacturers of Chlorine and Ammonia Control Apparatus
Belleville 9, New Jersey • Represented in Principal Cities

CD-24

. . . Controls All!

With Beaumont Birch Coal Handling Equipment, one operator controls *all* coal handling with finger-tip controls, like this—

Coal arrives by rail, is dumped into hopper, raised by bucket elevator and discharged either into bunker for immediate use or down a chute to yard storage. If it goes to storage, the Beaumont Drag Scraper spreads it into safe, compact layers—eliminating air pockets.

Use any available space. Tail-blocks can be slung between posts and moved by hand—and mechanically moved on I-beam track, by tail-block car, or suspended from an aerial bridle system. The scraper and cable system is operated by *one* man through remote control. *One* company, Beaumont Birch, supplies all necessary equipment.

Complete engineering service available by writing right now to—

BEAUMONT BIRCH COMPANY
1503 RACE STREET • PHILADELPHIA, PA.

Designers Manufacturers Erectors BULK MATERIAL HANDLING SYSTEM

ALLPAX

THE PACKING THAT "PACKS ALL"

. . . use it once and

. . . you'll use it always

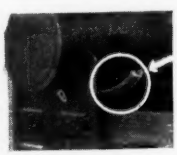
Here's the universal packing that can be used for any fluid or on any apparatus—economically, efficiently—tightly—simply.

Try ALLPAX and you, too, will be enthusiastic over its easy application and long wear. You don't have to remove old packing to repack with ALLPAX. Square cross section makes ALLPAX easy-filling in any stuffing box.

Try it and you'll always use it. Full details on request.

THEALLPAX CO., INC
Mamaroneck, N. Y.
●
Distributors Everywhere

"Boiler Repairs Reduced 75%"
writes user of NATIONAL GIRTH SEAM PROTECTOR



We have been using the National Girth Seam Protector for several years and they certainly do the job. . . . Have reduced our boiler repairs at least 75% since using these protectors, one of the best investments we ever made.
Von Platen-Fox Co.
Iron Mountain, Mich.

You, too, will find the National Girth Seam Protector saves trouble and money by preventing leaks and fire-cracking on new or old seams in boilers. Sections consist of wedge nut, cap screw metal lug and refractory covering; are easily attached. We can make immediate deliveries. Send for descriptive bulletin.

NATIONAL BOILER PROTECTOR CO., 928-29 REIBOLD BLDG., DAYTON, OHIO

178 **Weldments**—Bulletin SP106 tells about the services of this company's weldry and the weldments turned out therein. The products of this weldry are shown and the text points out how flexible the method is by showing that it makes no difference if the finished product is constructed of light sheet or heavy metal . . . the resulting product can be made to exacting specifications. Graver Tank & Mfg. Co., Inc.

179 **Drop Forged Flanges**—Manufacturing processes; physical characteristics; full-page tables of illustrations, dimensions, weights and prices. Space provided for future insertions. Phoenix Mfg. Co.

NEW ENGINEERING BOOKS

(*Continued from Page 154*)

industry and will be found useful in the home, factory, shop, office or in any place where one wants to know what to do and how to do it. With this book using only the simplest equipment, such as is found in any home or garage, you can make your own chemical from ingredients which are obtainable at most general or drug stores, and for those that are not, the book contains a long list giving the names and addresses of firms handling specific products. To compile the seventh volume of The Chemical Formulary, additional new formulas have been added which will broaden and bring up to date the contents of previous volumes. All the formulas in volumes previous to the seventh are different. Thus if you do not find what you are looking for in this volume, you may find it in one of the others. Accumulative index for the first six volumes is now available. This volume has the formulas divided under 21 classifications as follows:

Adhesives; Flavors and Beverages; Cosmetic and Drug Products; Emulsion and Colloids; Farm and Garden Specialties; Food Products; Inks and Marking Substances; Skins—Leather and Fur; Lubricants and Oils; Materials of Construction; Metals and Alloys; Paint, Varnish, Lacquer and Other Coatings; Paper, Photography; Polishes; Pyrotechnics and Explosives; Plastics, Resins, Rubber, Wax; Soap and Cleaners; Textiles and Fibers; and Miscellaneous. In addition there is a section giving valuable tables, also one on trade name chemicals and additional data valuable in supplies and equipment. This book is not a textbook nor a chemical manual, but takes on more the characteristics of a handbook which requires a minimum amount of chemical knowledge on the part of the user.

Industrial Electrical Heating and Electrical Furnaces, by E. S. Lincoln. First edition, 192 pages, size 6 by 8 inches, cloth, published by Duell, Sloan & Pearce, Inc., New York, N.Y., 1946, price $3.00.

This new volume in the Essential Modern Electrical Series opens with an introductory discussion of the three basic principles of electric wiring—resistance, infra-red and induction.

The first section of the book covers the fundamentals of resistance heating as they apply to the use of wires, ribbons, ovens, lamps, dryers, and other electrical devices. The second section of the book is devoted to the various uses of electric steam boilers, industrial heating cables and electric furnaces. Each of these devices is discussed in terms of its efficiency in the use of arc, resistance, and induction generation for melting, heat treating, and hardening purposes. Separate chapters are devoted to the selection of resistance elements, the calculation of heating requirements, and the methods of heating by convection, immersion and electrically-operated steam generators.

Switchboards and Panelboards, by E. S. Lincoln. First edition, 148 pages, 6 by 8 inches, cloth, published by Duell, Sloan & Pearce, New York, 1946, price $3.00.

This book describes and analyzes with a clear text, diagrams, and photographs the various modern industrial uses to which switchboards and panelboards are put. Metal-enclosed, truck, demountable-withdrawal, and rigid switchgear are described with data covering the use of both copper and aluminum bus bars. A special section is devoted to the uses and methods of installation of panelboards which employ fuses or circuit breakers.

PROPOSED CHILDREN'S MEDICAL CENTER, BOSTON, MASS.

CASE FOR A SPECIALIST....

Our broad experience and specialized knowledge in every phase of engineering and construction often are employed during the period of preliminary planning as well as for actual construction of institutional buildings.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY OF STONE & WEBSTER, INC.

There is only one REASON... why you use PACKING

And that is to prevent leakage somewhere

All leakage must be prevented wherever possible. It must be kept under control in all instances. Leakage is on the top of the list of musts that every Engineer has to contend with. And that is why Engineers are so anxious to get reliable rod packings ... why they use and are glad to endorse Quaker Brand Rod Packings.

Quaker has a brand to meet your service conditions. Even where your conditions are unusually severe ... be it oil, asphalt, acid or any other fluid.

Quaker is ready at all times to suggest and recommend the proper packings that will give the maximum results. Our packing experts will gladly help you.

Specify Quaker Packings. Buy from your local Mill Supply House or Hardware Dealer.

QUAKER ROD PACKINGS

A Complete Line of

Rubber
Duck and Rubber
Flax
Hydraulic
Asbestos
Metallic
Semi-Metallic

for all types of Service Conditions

QUAKER SHEET PACKINGS

Rubber
Asbestos
Fibre

For all service applications

REG. U. S. PAT. OFF.

QUAKER RUBBER CORPORATION

Mfrs. Industrial Rubber Products

PHILADELPHIA 24, PENNSYLVANIA

NEW YORK • CHICAGO • CLEVELAND • HOUSTON

Western Territory

Quaker Pacific Rubber Company

San Francisco • Los Angeles

POWER PLANT *Construction News*

Calif., Eureka—Pacific Gas & Electric Co., San Francisco, Calif., plans expansion and improvements in steam-electric generating station at Eureka, with installation of 12,567-hp turbine-generator and auxiliary equipment. Cost reported close to $480,000.

Calif., Fresno—Atchison, Topeka & Santa Fe Railroad Co., Sixth and Main Sts., Los Angeles, Calif., has approved plans for new one-story addition, 42 x 185 ft, to ice-manufacturing plant at Church Ave. and Railroad St., Fresno, reported to cost over $100,000, with equipment. Work will proceed at early date. Thomas Kendall, 1266 South Boyle St., Los Angeles, is engineer.

Conn., Newington—State Dept. of Buildings, Hartford, Conn., plans new boiler house at State Cedarcrest Sanitorium, Newington. Fund of about $300,000 has been arranged for this and other buildings at institution. Schilling & Goldbecker, 405 Temple St., New Haven, Conn., are architects.

Conn., Stamford—Connecticut Power Co., Stamford, has completed plans for new addition to local steam-electric generating station, and will begin work on steel frame superstructure at early date. Additional equipment will be installed for increased capacity. No official estimate of cost announced. Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass., is consulting engineer.

Ill, Red Bud—Town Council plans extensions and improvements in municipal power station, with installation of new 500-kw Diesel engine-generator unit and auxiliary equipment. Russell & Axon, 4903 Delmar Blvd., St. Louis, Mo., are consulting engineers.

Iowa, Glenwood—Town Council has made application to FWA for certain financing in connection with proposed new municipal plant It is understood that Diesel engine-generator units will be used. Entire project is reported to cost close to $250,000. Buell & Winter Engineering Co., Insurance Exchange Bldg., Sioux City, Iowa, is consulting engineer.

Iowa, Waukon—Interstate Power Co., Dubuque, Iowa, has begun preliminary work on new steam-electric generating station on Mississippi River, near Waukon, reported to cost about $4,000,000, with turbine-generator, high-pressure boilers and auxiliary equipment. Transmission lines will be extended.

Kan., Winfield—City Council plans extensions and improvements in municipal power plant, including installation of new high-pressure boiler and auxiliary equipment. Cost reported clase to $200,000. Kenneth Watts is city engineer.

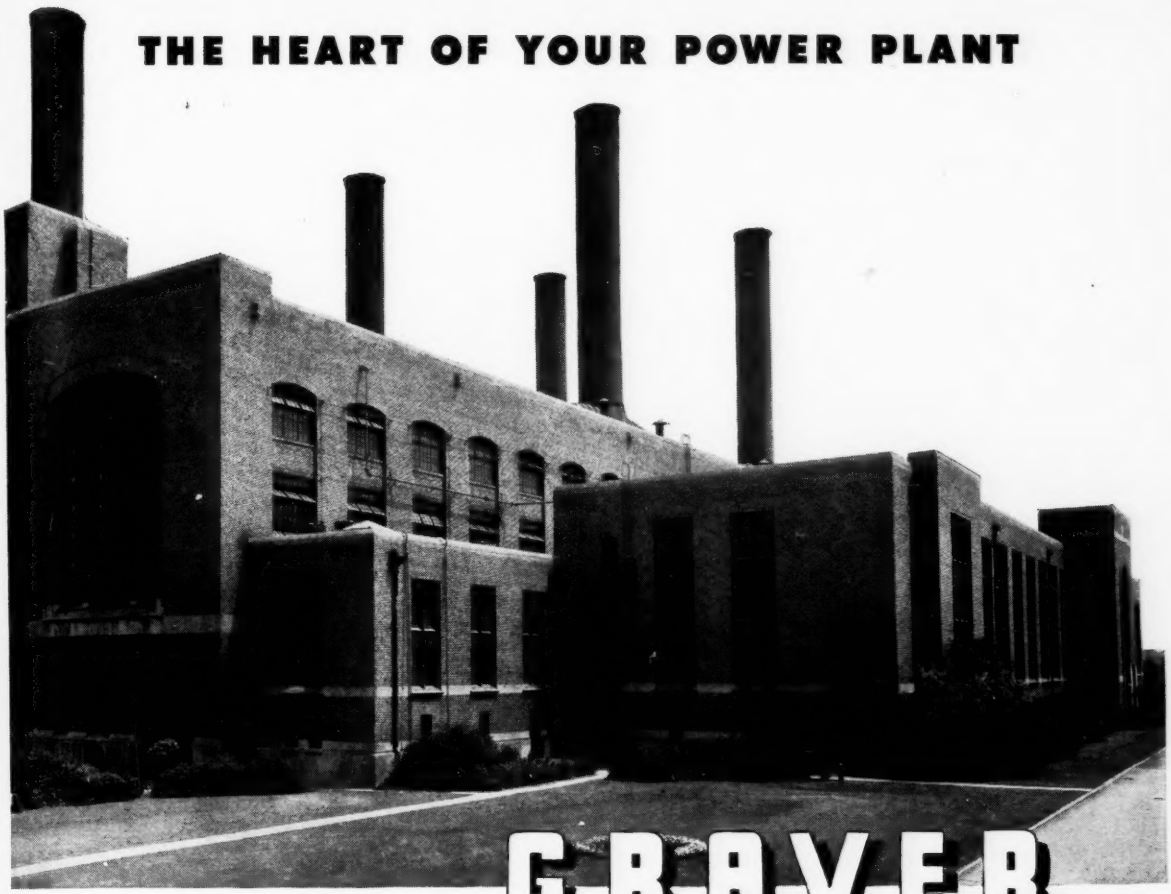
Mich., Frankenmuth—Frankenmuth Brewing Co., plans installation of electric power equipment in new addition to plant, reported to cost about $600,000. CPA has approved project and work will be carried out early in 1947.

Mich., Montague—Michigan Public Service Co., Traverse City, Mich., plans expansion and improvements in Diesel-electric power plant at Montague, with installation of equipment for increased capacity. Proposed to carry out work soon. Cost estimated about $200,000.

Minn., Albert Lea—Queen Stove Works, Inc., stoves, heaters, etc., plans installation of electric power equipment in new one-story addition to plant, 200 x 400 ft, for large increased capacity. Proposed to begin work in spring. Cost reported over $350,000.

Neb., Kearney—State Board of Education of State Normal Schools, Lincoln, Neb., plans new boiler house for central-heating service at State Teachers' College, Kearney, estimated to cost about $115,000. Proposed to arrange appropriation in that amount at early date.

THE HEART OF YOUR POWER PLANT



GRAVER

BOILER FEED CONDITIONING

MODERN power facilities demand *effective* boiler protection. That's why Graver equipment protects the very heart of your power plant . . . conditioning your boiler feed water . . . eliminating the scale-forming factors that mean trouble to the power engineer.

Graver Zeolite, Lime and Soda, Hot Process Softeners or Demineralizers and auxiliary equipment provide *complete conditioning.* Graver will build the proper water treatment plant based upon your raw water analysis and boiler plant design to deliver a boiler feed water perfectly conditioned for your specific requirements.

Why not call in a Graver engineer today?

WATER CONDITIONING AND PROCESS EQUIPMENT DIVISION

GRAVER TANK & MFG. CO., INC.

General Offices: East Chicago, Indiana

NEW YORK PHILADELPHIA CHICAGO

Graver's complete service includes design, fabrication and erection of every type of water conditioning equipment. This means an undivided responsibility and **better service** *to you.*

RUGGED

the phoenix flange

Every Phoenix Flange is a first quality drop forging . . . and the forging operation imparts a ruggedness that means safety and satisfaction wherever a Phoenix Flange is installed. A wide range of styles and sizes is available *now.* They're all shown in the latest catalog . . . your copy on request.

PHOENIX MANUFACTURING COMPANY

Catasauqua, Pa. Joliet, Illinois

Neb., Ogallala—Consumers Public Power District, Columbus, Neb., has approved plans for extensions in Diesel-electric generating station at Ogallala, including installation of two new 1600-hp generating units and auxiliary equipment. Cost reported about $260,000.

N.J., Dover—New Jersey Power & Light Co., Dover, plans addition to Holland steam-electric generating station, with installation of equipment for increased capacity. Cost estimated about $860,000. CPA permission has been secured and work will be carried out soon.

N.J., Elizabeth—Reichhold Chemicals, Inc., Ferndale, Detroit, Mich., synthetic resins, gums, colors, etc., plans new plant on tract of 7 acres of land recently acquired at Elizabeth, comprising several buildings for large capacity. Electric power equipment will be installed. A boiler house will be built. Entire project reported to cost about $1,000,000.

N.Y., Corning—New York State Electric & Gas Corp., Binghamton, N.Y., plans new steam-electric generating station in vicinity of Corning, reported to cost close to $900,000. Gilbert Associates, Inc., 412 Washington St., Reading, Pa., is consulting engineer.

N.Y., Poughkeepsie—International Business Machines Corp., 590 Madison Ave., New York, N.Y., plans installation of electric power equipment in new two-story basement addition to plant at Poughkeepsie, used for manufacture of electric typewriters. Cost reported over $500,000. Work will proceed at once.

N.C., Kannapolis—Cannon Mills Co., operating local cotton mills, plans extensions in steam power plant, with installation of boilers and auxiliary equipment for increased capacity, to be used for steam supply for a central-heating system in business section of town.

N.D., Bottineau—State Board of Higher Education, Bismarck, N.D., plans new boiler house for central-heating service at State School of Forestry, Bottineau. Appropriation is being arranged.

Okla., Harrah—Oklahoma Gas & Electric Co., Oklahoma City, Okla., has plans maturing for expansion in Horseshoe Lake generating station, Harrah, including installation of new 12,500-kw turbine generator, boiler and auxiliary equipment. Cost reported close to $1,000,000. Company also will increase capacity of Lincoln Beerblower steam-electric power plant at Ponca City, Okla., with installation of a new 20,000-kw turbine-generator and accessories. Cost estimated about $1,500,000.

Pa., Peckville—Blakely Borough Electric Dept., Borough Bldg., Peckville, is considering extensions and improvements in municipal power station, including installation of additional steam-electric generating equipment. Cost reported over $400,000.

S.D., Sioux Falls—Northern States Power Co., Minneapolis, Minn., has approved plans for new steam-electric generating station on Big Sioux River near Sioux Falls, to replace present power plant at that place. Installation will include a 12,500-kw turbine-generator, boiler and auxiliary equipment. A power substation will be built. Cost estimated about $1,500000. Completion is scheduled late in 1947. Extensions to initial plant are contemplated at later date, making total investment of close to $5,000.000.

Texas, Houston—National Steel Products., 1901 Franklin St., general steel products, plans installation of electric power equipment in new plant on local tract of about 10 acres of land, recently acquired. It will comprise several one story buildings for fabricating service and auxiliary structures. Cost estimated close to $1,000,000. Company is a subsidiary of National Steel Corp., Grant Bldg., Pittsburgh, Pa.

Wis., Dewey—Dairyland Power Cooperative, Rivoli Bldg., LaCrosse, Wis., has plans maturing for new power dam, about 400 ft long, and hydro-electric generating station on Flambeau River at Dewey, near Ladysmith. No estimate of cost announced. Proposed to ask bids in March. Fargo Engineering Co., Jackson Mich., is consulting engineer.